

th heritage HERITAGE
Earth HERITAGE
heritage

The geological and landscape conservation magazine



**Pictures at
an exhibition**

Geology and landscape as
artforms

Issue
20
Summer 2003

**Earth science
teaching**

Breathing new life into the
subject

Action packed

Actions speak louder than words, so the saying goes, and the features in this issue demonstrate the effectiveness of the wide range of geoconservation activities currently being undertaken.

Take, for example, the ESEU initiative reported by Chris King to boost the teaching of Earth Sciences and to encourage and enthuse tomorrow's geoscientists. Then there's the action-packed Scottish Geology Festival. A photographic exhibition in Wales of geological art represents an entirely different means of popularising our subject. Community action which saved a Scottish SSSI is the focus of another article, and we also report on how partnership working in Wales ensures that potentially competing interests on the Great Orme work effectively together. Appetite for 'geoconservation' work – the real nitty-gritty of our cause – seems insatiable; 32 improvement projects, worth no less than £2 million, are already planned to take advantage of the Aggregates Levy Sustainability Fund in England! More will surely follow.

Of course, there are numerous hills still to climb! The RIGS initiative in Scotland needs further expansion, and the annual UKRIGS Conference planned for West Lothian later this year may provide the impetus. Mick Stanley reports that the issues of mineral collecting need further airing, and Cynthia Burek highlights the parlous state of many important geological collections.

Our most vigilant readers might be aware that *Earth Heritage* magazine is approaching its 10th birthday – a fact we hope to celebrate with our next issue. *Earth Heritage* is free, and if this copy of the magazine is not your own, please

e-mail the nearest editor (*below*) to be placed on our mailing list.



Stewart Campbell,
Managing Editor

Earth heritage

Earth Heritage is a twice-yearly magazine produced for the geological and landscape conservation community by the Joint Nature Conservation Committee, English Nature, Scottish Natural Heritage and the Countryside Council for Wales.

The UKRIGS Geoconservation Association is a principal contributing partner. We would like to thank all those who have assisted with the preparation of the magazine. However, the opinions expressed by the contributors are not necessarily those of the above organisations. A complete database listing all the articles carried in previous issues is available on CD. Contact any member of the editorial board.

Key articles from this and previous issues of *Earth Heritage* can be found on the Web at: www.seaburysalmon.com/earth.html

Offers of articles should be directed to the relevant members of the editorial board, who are:

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'Ayer's Rock', Rhoscolyn, one of the photographs at an exhibition of work by Stewart Campbell, Managing Editor of *Earth Heritage*. See page 13.

Scots ready to Rock On in 2003

The Rock On - Scottish Geology Festival 2003 will be launched at Our Dynamic Earth in Edinburgh on 13 September.

Aimed at bringing geology to the people of Scotland, this biennial festival extends itself from one to two weeks for the first time – to accommodate the ever increasing number of events being offered by enthusiastic Earth scientists and organisations across the country.

Ice will be the main theme of this year's launch event, to echo the centenary of the Scottish National Antarctic Expedition, led by William Speirs Bruce, Scotland's most eminent polar explorer.

When organising 'Rock On' the aim is to make geology, and Earth Science in general, available to everyone. We would like to further the knowledge of those already interested, but more importantly, we want to arouse the interest of those who have little or no knowledge of the subject. So far, around 100 different events have been registered, including: mine and quarry visits; geological rambles; guided walks to examine ice-sculpted landscapes; lectures and talks; gold and silver panning; rock 'surgeries'; building stones walks; dry-stone walling demonstrations; and a guided tour of Historic Scotland's stone conservation studios.

The British Geological Survey Open Day at Murchison House in Edinburgh, on 27 September, is a major Festival event at which the winners of Primary and Secondary School competitions being run as part of 'Rock On' will receive their prizes. Now run annually, the schools competitions this year are designed to stimulate pupils' curiosity about landscape formation during the last Ice Age (secondary school competition) and the life that may be around during a future ice age (primary school competition).

Although Scottish Natural Heritage co-ordinates the organisation of 'Rock On', the geology festival is very much a partnership effort, bringing together those in Scotland in the field of communicating

geology to the public, namely: National Museums of Scotland, Our Dynamic Earth, British Geological Survey, Hunterian Museum, the Scottish Earth Science Education Forum, and the geological societies of Glasgow, the Open University, and Edinburgh.

The recently developed website, www.scottishgeology.com, will this summer provide a list of all the events taking place during the festival. Closer to the event itself, a national and local effort will publicise 'Rock On'. The 'Rock On' organisers are grateful for the support of the Quarry Products Association and Scotrail.

COLIN MACFADYEN,
Chair, 'Rock On' Organising Committee
and
DIANE MITCHELL,
'Rock On' Events co-ordinator

Landscape conference

The *Conserving our Recent Past* conference hosted by the University of Bournemouth in June brought academics and practitioners in Earth heritage conservation together to share experience and best practice in the conservation of our active landscape and its recent past. It featured speakers from Archaeology, Built Heritage, and the Earth Sciences and was geared to help define and explore areas of common ground within these disciplines in landscape conservation.

Themes explored included:

- Conflicting conservation interests
- Conserving active processes
- Best and worst practice in conserving unconsolidated materials
- Conservation of peat and soils
- Approaches to conserving our recent past

The conference, sponsored by the Geoconservation Commission, the University of Bournemouth, the Quaternary Research Association and the British Geomorphological Research Group, proved to be of interest to local planners, RIGS groups, statutory conservation agencies, archaeologists and environmental consultants. There will be a report in the next issue of *Earth Heritage*.

Web site update

The Minerals and Nature Conservation Forum website at www.qpa.org has been updated to include geodiversity as well as biodiversity and quarrying. It now includes background information and case studies considering how the extractive industry contributes to the conservation of our geological heritage. In addition, the new *Geodiversity and the minerals industry* publication (see page 26) is available to download.

Geopark for the Malverns?

The Malvern Hills – centrepiece of the proposed European Geopark.

Photo by Peter Wakely/English Nature

Abberley and Malvern Hills, falling in four counties – Worcestershire, Herefordshire, Shropshire and Gloucestershire, is to be proposed as one of the country's first European geoparks.

The boundaries of its 1,000 sq km are the water courses of the Rivers Wye, Frome and Leaden in the west and Severn in the east. There are the Malverns AONB, several SSSIs, two National Nature Reserves, 40 RIGS, Scheduled Ancient Monuments, hundreds of listed buildings, magnificent churches and country houses and spectacular countryside within its boundaries.

Rocks from virtually all the geological column are represented except the Cretaceous and Tertiary which were eroded during the last 60 million years. At the heart is the late Precambrian Malvern complex, at least 677Ma. The youngest sediments are being laid down in the rivers today.

The fossiliferous Silurian rocks, building stones from the Devonian and Triassic, Permian breccia, the Carboniferous Coal Measures and the Cambrian Malvern quartzite are some of the other rocks to be seen.

The founding partners have amassed an impressive 38 reasons for a Geopark, ranging from the rare exposures of the Precambrian basement to important Quaternary deposits and features especially



periglacial, glacial, fluvial and mass movement. But a European Geopark has to be able to support education, raise general awareness and training, develop scientific research, enhance the natural environment and have sustainable development policies. These will all need to be in place before the Geopark can be established.

To launch its proposal, the Herefordshire and Worcestershire Earth Heritage Trust invited representatives from 40 organisations to explain why the Geopark should be established. The guests were taken on a visual tour of the geological and geomorphological history, introduced to their extensive public education and awareness programme and the completed or proposed geoconservation work. A coach tour of highlights confirmed the

Earth Science elements and the potential for geotourism and sustainable development.

The support of local authorities will be crucial to the success of this exciting proposal. The Earth Heritage Trust is to be congratulated for its vision of geological and landscape conservation.

MICK STANLEY,
Geodiversity Consulting

- Herefordshire and Worcestershire Earth Heritage Trust has released the latest in its series of laminated local trail guides – a building stones trail around Malvern. More information from Peter Oliver on 01905 855184.

Earliest cave art found at Creswell

What is believed to be Britain's first Ice Age cave art has been found at Creswell Crags on the Nottinghamshire-Derbyshire border. April's discovery of 12,000-year-

old engravings by archaeologists Sergio Ripoll, Paul Bahn and Paul Pettitt makes Creswell Crags the most northerly place on Earth where Ice Age cave art has been

found. Creswell Crags is a geological Site of Special Scientific Interest. The site is also a Scheduled Ancient Monument (SAM) because of its national archaeological importance. English Nature and English Heritage assist Creswell Heritage Trust with the sensitive management of these respective interests.

Creswell's celebrated cave deposits have yielded prolific mammalian remains as well as Palaeolithic artefacts. They are thought to provide a complete stratigraphical record from 'Middle Palaeolithic' to early post-Palaeolithic times, which makes them important to both Quaternary geology and to archaeology.

Creswell Crags is one of the three richest sites in Britain for fossil mammals. Both the sediments in the caves and in the valley slopes below the caves have yielded prolific mammal remains, including spotted hyaena, woolly rhino, reindeer and mammoth.



An etching of a bovid animal found in one of the Creswell caves. Photo by Sergio Ripoll

Knockan Crag Centre

THE FIRST YEAR

(and a half)

The Knockan Crag visitor facility has now been open for 18 months. Despite some initial teething problems with the interactive interpretation (the Moine Machine refused to thrust and Scotland was stuck at the South Pole), the site is proving to be very popular.

Between 24 April and 31 October 2002, there were over 17,000 visitors, compared to the estimated 15,000 visitors per annum visiting before redevelopment. Most of this increase could be accounted for by the improved promotion of the site since redevelopment, but judging by the reaction of local people and accommodation providers, the site is seen as an asset to the area and more personal recommendations to visit are being made.

A visitor survey carried out last summer revealed that 4% of visitors were from within 30 miles of the site; 38% from the rest of Scotland; 37% from the rest of the UK; 21% from overseas (of which 9% were French, 29% German, 2% each of Italian, Dutch and Spanish, 24% Swiss, 7% Scandinavian, 19% Australian and 5% from the USA). In response to the comments and results of the survey, Scottish Natural Heritage is planning



Photos by Lorne Gill/Scottish Natural Heritage

developments that include a NNR leaflet with more information about the geology and landscape; a new orientation panel in the car park; and a panel on the Crag Top trail interpreting the glaciated landscape below. The website will include more on geology and landscape.

Scottish Natural Heritage proposes to produce an education pack provisionally titled 'Scotland's Journey' aimed at upper primary/lower secondary level and linked to the Scottish 5-14 curriculum. It will explain Scotland's journey from near the South Pole to its present position and how geology helps tell the story. The proposal includes site-specific packs to allow teachers to relate the wider picture described in the pack to local sites.

As a pilot for the site-specific information, Dr Peter Craig has produced an education pack for Knockan Crag. It contains interpretative material in a CD ROM, a rock box, teachers' notes and activity

sheets. English and Gaelic versions will be supplied to the primary and secondary schools in the locality, with copies available from the Scottish Natural Heritage Ullapool office for visiting schools.

The Knockan Centre received invaluable funding from the Geologists' Association, Caithness and Sutherland Enterprise, Ross and Cromarty Enterprise, the Heritage Lottery Fund, the European Regional Development Fund under the Highlands and Islands Objective 1 Partnership Programme, British Geological Survey, Cashmaster International and Scottish Natural Heritage.

JAN BRECKENRIDGE,
Scottish Natural Heritage



Revealed - missing Birk Knowes fossil

Earth Heritage can reveal for the first time an image of one of the fossils taken without permission from



Birk Knowes, one of Scotland's most important palaeontological SSSIs. This extremely rare, beautifully preserved and scientifically important fossil is of an enigmatic marine arthropod known as *Ainiiktozoon loganense*. Thought to have been taken in the mid-1990s, the specimen forms part of the Eddinger Collection bought by the Humboldt Museum in Berlin in late 1998. Scottish Natural Heritage is continuing its campaign to repatriate this and other fossils taken from the site.

North Somerset's RIGS reviewed and extended

The Avon RIGS Group has undertaken a full review of all North Somerset Council's designated RIGS. The DETR-funded project revealed a number of problems with RIGS designated 10 or more years ago. Some sites were not known to present Avon Group members, a few sites had been lost to infilling. The review extended or combined other RIGS to make them more suitable for the sites involved. In the end, the Group proposed that 45 existing RIGS should be re-designated.

The review also provided the opportunity to look at gaps in the series and several new sites were proposed. The total number of RIGS proposed for North Somerset is 68. Up-to-date descriptions for all the sites are in the Local Plan, together with brief descriptions of the interest of each site for use by non-specialists. The full list of RIGS in North Somerset can now be seen on the Council's Website, www.n-somerset.gov.uk

The road to better site maintenance



Clearing the Bromsgrove SSSI.

Photo by English Nature

Work to re-expose geological features on a Site of Special Scientific Interest resulted in a road closure in Worcestershire earlier this year.

English Nature applied to the Highways Authority for a temporary road closure to allow Herefordshire and Worcestershire Earth Heritage Trust carefully to clear vegetation to reveal an unconformity between the Bromsgrove Sandstone Formation and Wildmoor Sandstone Formation.

Many local people were perhaps not aware of the importance of the roadside cutting along Old Burcot Lane, north-east of Bromsgrove. English Nature notified a 350-metre stretch of the lane cutting as an SSSI in 1991. The site is of special interest because of the unconformity and the rocks it exposes. These allow geologists to study the conditions and climate when the material was laid down in a series of meandering rivers some 240 million years ago during the Triassic.



Dr Doug Paton and a NESciE workshop.

© Peter Tuffy, University of Edinburgh

£10,000 grant rewards education efforts

The Scottish Earth Science Education Forum's (SESEF) efforts to help improve school Earth Science education have been recognised with a £10,000 Science in the Community Award from the Scottish Executive and Royal Society of Edinburgh. It was won in conjunction with Natural Environmental Science Education (NESciE).

This is important recognition of Earth Science education in Scotland because SESEF was competing with several well-established, high-quality, science education providers. The award will be spent on exploring the integration of pupils' workshops, teachers' Continuing Professional Development, and science community events in Scotland's remote areas. The core products are NESciE's award-winning 'Design a Dinosaur' and 'Scotland: hot, dry and sunny' workshops.

For activities directly involving Scottish school pupils, SESEF is happily involved with a number of important partners. The National Museums of Scotland Rock Map project was reported in *issue 19*. The Rock On Scottish Geology Festival takes place in September this year (*see page 3*). SESEF is a young organisation and Continuing Professional Development

(CPD) for primary school teachers has been an early focus. It is developing CPD to cover the Earth Science content of the primary Science curriculum.

This work is in conjunction with the Royal Observatory Edinburgh and the Earth Science Education Unit at Keele University. Important aspects include children's science and thinking skills, and highlighting opportunities for teachers to draw in Earth Science material from elsewhere in the curriculum (landscape, climate and the physical environment are tied in with social subjects). It is now looking at ways of supporting school Earth Science education through, for example, Scotland's local museums.

SESEF sees the education system as an integrated whole. It is currently bidding for funds to support a major project that both investigates and develops the links between Earth and Environmental Science departments in Scotland's universities and their local secondary schools.

For more information on SESEF's activities, or to work in partnership with SESEF, please contact the Development Officer: SESEF@ed.ac.uk

– HAMISH ROSS, SESEF

Wind of change

that saved a Tertiary site

Nick Everett,
Scottish Natural Heritage,
on how an exemplary SSSI was saved from destruction



At the official opening of the community site, Gordon MP Malcolm Bruce (right) helps the oldest (Ann Stratton) and youngest (Ben Raffan) members of Woodhead and Windyhills Community Trust to cut the ribbon at the site launch, watched by Trust Chairman Leon Smith. Ben is with his mum, Kate.
Photo by George MacRae

Windyhills SSSI in north-east Scotland may not have the most enticing name, but local people have long appreciated this valuable wildlife haven of semi-natural woods surrounded by farmland. However, few knew that it is an outlier of Tertiary sediment so unique that it is internationally important. Now the community has bought the site, and can start managing its 'hidden treasure'.

As subtropical Scotland sweltered in the Tertiary, the glitzy west coast flaunted its volcanism, localised uplift, and eye-catching laterisation. Humble north-east Scotland stoically endured deep weathering and steady denudation, but with an eye to the gluttonous North Sea Basin it hoarded a connoisseur's collection of isolated Tertiary souvenirs. The bedrock weathering profiles and etched landforms are remarkable, but the real stars are the preserved sediments.

At Windyhills, near Fyvie in the rolling low plateaux of north Aberdeenshire, small pits expose striking quartzite gravels,

clearly deposited in flowing water. After 150 years of study we still don't know whether they are *in situ* river deposits – which implies, slightly mind-bogglingly, topographic inversion of today's hill-top location – or were ice-rafted into place. Either way, their pervasive kaolinitic weathering indicates at least a Pliocene age, making the gravels an exceptional sedimentary 'glimpse' of a Scottish epoch dominated by erosion. As such, they have for decades been a perplexing must-see for groups of students and researchers from around the world.

The few established pits provide an ideal balance between exposure and integrity of the whole deposit. However, the Windyhills gravels are also a potentially high-value mineral resource, and planning permission for quarrying away the whole site existed long before SSSI notification. Matters came to a head in 1999 with a review of the minerals permission, which drew an objection by Scottish Natural Heritage. New University of Aberdeen/SNH research emphasised that even partial loss would irrevocably damage the SSSI. Understandably, Aberdeenshire

Council did not relish the alternative of modifying the consent and becoming liable for profit foregone! The breakthrough came in 2000 when the owners, Tarmac Northern Ltd, indicated that they were willing to sell Windyhills to the community at a price based on the land investment, rather than on potential profit.

Local people resisting the quarry proposals regrouped as Woodhead and Windyhills Community Trust, and worked closely with Tarmac, Aberdeenshire Council and Scottish Natural Heritage. Impressive efforts saw funds raised for drawing up management and business plans, initial clean-up of the site, and legal costs. Those providing financial support ranged from local individuals and businesses to the Geologists' Association, Exxon Mobil, Scottish Natural Heritage and the Scottish Land Fund who funded most of the land purchase. Considerable media interest has seen several stories doing gratifying justice to the site's geological significance.

The community launched their newly acquired 40-hectare site in March. Issues to be tackled now include responsible recreation, areas of past dumping, and maintaining an accessible yet low-key path network. The Earth Science story, nature conservation assets, and the site's use over recent centuries are ideal for on-site interpretation, beginning with a Scottish Geology Festival guided walk in September.

The Windyhills deposits and others in the area have no equal in Britain, yet their origin remains enigmatic, making them a unique conservation resource. Five years ago Windyhills faced possible destruction. Now it is on its way to being a model of integrated SSSI management. ■



A party visits the quartzite gravels.

Photo by Nick Everett/Scottish Natural Heritage

Mike Browne and David McAdam look at what has happened to Regionally Important Geological / Geomorphological Sites (RIGS) groups in Scotland in the 10 years since the founding of the Lothian and Borders RIGS Group, in September 1992

RIGS in Scotland 10 years on

Scotland's nationally important geological sites may be safeguarded through notification by Scottish Natural Heritage as Sites of Special Scientific Interest, but what about conservation and management of regionally important sites?

There is the clear need for geoconservation at the local level, with the enhancement and interpretation of unprotected elements of the Earth heritage, through the non-statutory designation of RIGS. These are defined according to four criteria: educational, research, historical and aesthetic. To date in Scotland, the emphasis has been the designation of sites for education and interpretation. However, the aspiration is to have designations echoing all the founding criteria and have a 'RIGS in Scotland' network of groups.

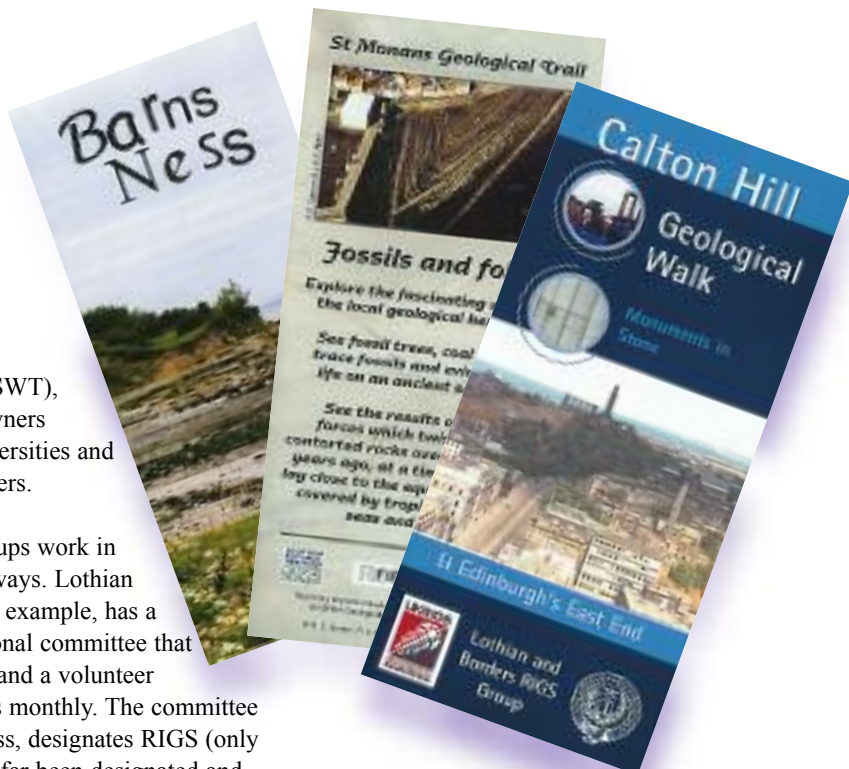
Currently there are six Scottish RIGS groups: Fife, Highlands, Lothian and Borders, Stirling and Clackmannan, Tayside and Strathclyde. Representatives and volunteers on these groups include local authority planners, rangers, museum and education services, Scottish Natural Heritage advisory and area staff, British Geological Survey (BGS), Scottish

Wildlife Trust (SWT), Scottish Landowners Federation, universities and amateur volunteers.

Local RIGS groups work in many different ways. Lothian and Borders, for example, has a mainly professional committee that meets quarterly and a volunteer group that meets monthly. The committee monitors progress, designates RIGS (only 16 sites have so far been designated and listed in Scotland) and directs the volunteers in producing interpretation leaflets and posters and visiting existing or potential RIGS. It is still the only Scottish group to have employed a RIGS officer (based at the local SNH office), who compiled a digital database of over 150 possible sites. Conservation and management plans have been prepared for Torphin Quarry RIGS and Petershill Reservoir Quarry. Petershill is managed by volunteers on behalf of the owners, the SWT. This involves regular work parties to clear the site of rubbish, maintain access to exposures and conserve the wetland floor.

Colour-printed interpretative leaflets produced by the Lothian and Borders and Fife groups for sites such as Calton Hill and St Monans are produced through grant-aid and distributed free. Funding has come from sources as diverse as SNH, BGS, UKRIGS, Landfill Tax, Curry Fund of the Geologists' Association, Edinburgh World Heritage Trust, West Lothian and Fife councils, and local amenity and community associations. Simple photocopied leaflets have been printed by the local council as sponsorship.

West Lothian Geological Heritage poster by Lothian & Borders; others in series: East Lothian Geological Heritage, Corstorphine Hill RIGS, Hermitage of Braids and Blackford Hill RIGS, Joppa Shore RIGS, Roslin Glen, and Union Canal (one each for Edinburgh, West Lothian and Falkirk).



Barns Ness leaflet jointly published by Lothian & Borders and Girlguiding East Lothian. St Monans Geological Trail by Fife RIGS, other in series: St Andrews. Calton Hill World Heritage Site leaflet by Lothian & Borders; others in series - Corstorphine Hill RIGS, RIGS in Scotland (for use by any Group) and (planned) Craighleith Quarry RIGS.

A recent success was a collaboration with GirlGuiding East Lothian. Three of the Lothian & Borders Group geologists showed the Haddington Guides the geology at Barns Ness, near Dunbar. The result was the Barns Ness leaflet in a refreshingly new style, designed for children by children and an accompanying Geology Action Pack for Girl Guides. (This year's site for this treatment is the volcanic rocks at North Berwick.) The Barns Ness leaflet and Action Pack are being entered (with high hopes) for the annual prestigious LASMO Awards.

Posters, at A2, A3 or A4, are a medium used extensively by Lothian & Borders group, and emulated by the Fife group. Posters are either general or site-specific, such as the three prepared for the Union Canal and Corstorphine Hill.

Field excursions led by the Lothian & Borders group are an accepted part of the annual Edinburgh International Science Festival. Several groups contribute to the biennial Scottish Geology Festival and the Fife group to their local Council's own environmental events.



Fife RIGS, founded in May 1994, meets regularly. The group has a skeletal listing of 200-plus potential sites but has yet to designate one. Geological trail leaflets for parts of the Fife coastal path and a Fife RIGS poster have been published. The group is working with Geoheritage Fife, a voluntary group responsible for the St Andrews Geological Wall and Jurassic Garden projects.

Stirling & Clackmannan RIGS, founded in November 2001, has already exhibited at the Annual Symposium of the Forth Naturalist and Historian. By the time of this article they should have listed their first site, Mine Woods at Bridge of Allan (including Wolf's Hole Quarry and The Copper Mine). Field visits have assessed potential sites as in the Bannock Burn, at Callander and in the Campsie Hills.

Tayside RIGS, founded in September 1994, but effectively dormant, has a skeletal listing of many potential sites, though Angus is under-represented. The group commissioned a report, funded by Scottish Natural Heritage, on the potential RIGS in Dundee and 10 were considered for RIGS status. Two, Dundee Law and Stannergate Shore, have been designated together with Balkello Community Woodlands and Seaton Cliffs, Arbroath in Angus. The Group held a promising one-day workshop with local teachers and rangers, but more RIGS input is needed to maintain the impetus.

Highland RIGS was founded in June 1995. Faced with a myriad of sites of geological and geomorphological interest but few geologists, there is still not a single RIGS

in the Highland Region; the problem has been swamping by rather large tasks of a very small, partly amateur, un-resourced group.

RIGS groups flourish best when allied to other groups. Both Lothian & Borders and Stirling & Clackmannan are committees of the Edinburgh Geological Society, and the Highland group was set up by the Highland Geological Society. Such links enable a group to come under the parent body's constitution, whereas the Fife and Tayside groups both have an informal constitution. Moves are afoot to form further Scottish RIGS groups. In the west, a Strathclyde RIGS Group has just been formed within the Geological Society of Glasgow, involving the Scottish branch of the Open University Geological Society. Interest in starting groups has been shown in Argyll, Shetland and Morayshire.

The setting up of a RIGS group requires people with a collectively wide range of skills. Although reasonable numbers of people have supported the work of the various RIGS groups, there has been a disappointing response by the professional geological community to involvement with the nitty gritty of site work.

Funding

So far insufficient finance has been found to support RIGS manpower in Scotland, although Scottish Natural Heritage has funded specific projects. Approaches for Landfill Tax money were unsuccessful because the need for core funding of a RIGS project officer was at odds with the site-specific work that would have

qualified. Similar remarks apply to Heritage Lottery Scotland. Publication of leaflets and posters has been supported by many groups (as listed above). However it is difficult to imagine a time when £600 might be collected at a 'can' appeal day for RIGS at the local supermarket – unlike local wildlife trusts!

Scottish Natural Heritage financially supported a part-time Scottish RIGS Officer for two years and in that time, Kath Leys helped frame a proto-Scottish RIGS Association and drafted a national RIGS strategy. As yet the strategy is unadopted and the only national association for RIGS in Scotland (unlike Wales) is UKRIGS. She developed links to biodiversity and, with COSLA (Convention of Scottish Local Authorities), produced a planning sector guidance note on geodiversity for the Scottish Biodiversity Group (hosted in the Scottish Executive).

RIGS groups are involved in Local Biodiversity Action Plans (LBAP) work in east central Scotland. The SWT has recently put in place a sympathetic national policy on geodiversity in the appendices of which were included both the guidance note and the draft Scottish RIGS strategy. Again in central Scotland, some councils have policies about RIGS protection in both their structure and local plans. The future in this area is to build RIGS into council environmental network strategies and local community planning, as in Fife.

The RIGS initiative in Scotland has to be greatly expanded. The opportunity for a renaissance should come on 27-29 October, with the UKRIGS annual conference at Oatridge Agricultural College, West Lothian. The programme will include a workshop to revisit the draft Scottish RIGS strategy and prepare an action plan. The plan might include seeking resources to fund a Scottish RIGS project officer, and to encourage new groups throughout Scotland and set up a 'RIGS in Scotland' network. ■

Edinburgh International Science Festival walk on glaciated dolerite pavement on Corstorphine Hill, April 1999, led by Lothian & Borders RIGS Group.

Photo by Lothian & Borders RIGS Group



Below, pot-holes representing ancient forest on limestone, seen at Catcraig, East Lothian.

Photo by T Bain. IPR/42-42C British Geological Survey. © NERC. All rights reserved.



Breathing new life into Earth Science teaching

Chris King,
*Director, Earth Science
Education Unit*

The Earth Science Education Unit's network of facilitators across most of England and Wales offers interactive 'hands on' workshops to secondary Science departments through In Service and Training (INSET) sessions. These may bring their Earth Science teaching to life in ways that they had not previously imagined. ESEU's 28 facilitators come from all walks of Earth Science life. Some are school teachers, University lecturers or Open University tutors, some work in industry and some are retired. They all share an enthusiasm for Earth Science, a knowledge of how poorly it can be taught in schools, and ESEU training for the job in hand. They work as ambassadors in their local areas, communicating with local schools and providing workshops.

The 90-minute workshops are packed with practical ideas and interaction with teachers. Some are aimed at teachers of KS3 pupils (aged 11 to 14) and some at KS4 pupils (aged 14 to 16). They include: 'Spot that Rock' – how to identify rocks from first principles; 'The Dynamic Rock Cycle' – investigating rock-cycle processes in the lab through practical experiments; and 'The Plate Tectonic Interactive' - using practical approaches to highlight the evidence and explanation of plate tectonic theory. The workshops don't stop at the classroom door, 'Earth

Science out of doors' uses the school



Above: Teachers deciding where rock specimens belong in the Rock Cycle.

A student examines a war grave to see the tiny spheres which make up Portland Stone.

All photos by Peter Kennett



building and playground to teach Earth Science principles, often without a rock in sight! 'Will my gravestone last?' involves a range of investigations based on the variety of rocks seen in many graveyards. These workshops are revitalising Earth Science teaching across the country.

As ESEU has grown, it has offered more than 200 workshops to over 1,500 science teachers and 1,000 trainee teachers. All participants are asked to score the workshops on a 1 (high) to 5 (low) scale, and the mean score to date is 1.5 – a very high score for people who have often come to Earth Science reluctantly.

Left: Teachers trying to reconstruct the former positions of the continents from the evidence of fossils.

What teachers think of the ESEU workshops

"... which I will certainly use in my classes. Particularly like the way experiments were related to what happens on the Earth's surface." - a science teacher attending an ESEU workshop in Birmingham.

"Brilliant INSET – did a lot for me and my department. I would recommend this to all schools." - a Head of Science from Droylsden.

"Will change my teaching of rocks dramatically – never been my strong point" - a science teacher in a Lancashire school.

"I have been teaching for 12 years and run a huge faculty. This has done more to refresh my brain and improve teaching than most other INSET has in the past 5 years (and I've done a lot!) Outstanding delivery." - a Head of Science from Birmingham.

So why is ESEU able to offer Earth Science workshops free to schools in a way that is unique in the UK and possibly across the world? The answer lies in a successful industry/education partnership between Keele University, providing the 'home' for ESEU, the Earth Science Teachers' Association, providing many of the resources and workshop expertise, and the UK offshore oil industry (UKOOA – UK Offshore Operators' Association), which gives financial support and a crucial business perspective. The partnership ran a pilot project in the Midlands and North of England which laid the foundation for the current national rollout. Following a 'grand launch' in the Earth Galleries of the Natural History Museum in London last year, the 'Welsh launch' took place in the National Museum & Gallery Cardiff in June 2003. Piloting begins in Scotland this year as well – developing workshops that target the different curriculum north of the border.

Why is the oil industry supporting Earth Science education? The answer comes in several parts. The amount of Earth Science



Photo by Dave Evans/English Nature

Making Sites of Special Educational Interest...

Dave Evans,
English Nature

content remains – dispersed throughout the rest of the science curriculum. There is potential for links with geological SSSIs and other sites. However, there are often substantial legal, logistical and financial obstacles that teachers must surmount if they are to use such sites as outdoor classrooms. Partly because of the limited duration of the project, information about current site usage (whether SSSIs or other sites) was sparse, but such data would help identify suitable sites and potential uses.

These findings will inform a number of site-related pilot schemes and are useful to English Nature's Nature on Line initiative. Although we only looked at the science and geography curricula, schemes such as the Waves Project, a joint venture run by the Local Education Authority and the Museums Service of Dudley Metropolitan Borough, make it clear that opportunities for site-based teaching exist throughout the curriculum. ■

The project findings are due to be published as an English Nature Research Report and will be available from English Nature's website, www.english-nature.org.uk.

Although the 1,240 or so Sites of Special Scientific Interest (SSSI) in England designated for their geological interest exist primarily to show the geology and geological history of Britain, they could also have a role in school education. Some SSSIs, particularly on the coast, in the uplands, and in working and disused quarries, are used regularly by universities and sixth-form colleges for geological field work; but what use might schools make of them?

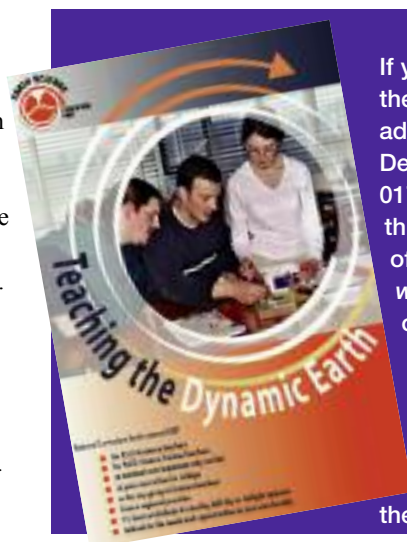
Potentially the promotion of appropriate SSSIs could help the positive management of these SSSIs as well as raising awareness of geology and geological conservation. Last year,

English Nature asked Ian Thomas of the National Stone Centre to investigate the potential links between the National Curriculum and geological sites. The first objective was to identify areas within the science and geography curricula for Key Stages 1-3 that had potential links to geology/Earth Science and could give teachers good reason to use suitable sites. The second was to provide an overview of the legal, logistical and financial problems faced by teachers taking students out of the classroom. Finally, a brief review of the current usage of sites by schools/educational groups was carried out.

Ian's key findings make it clear that despite the disappearance of a separate Earth Science curriculum, much of its

in the National Curriculum for Science is small but significant. However, most science teachers teaching Earth Science have little or no Earth Science in their own backgrounds and their main form of support is school science textbooks (King, 2001). A recent survey of the Earth Science content of these textbooks has shown that the quality is very variable, and often poor. The mean error level is one mistake per page of Earth Science, with the worst culprit having 66 errors in 26 pages (King *et al.*, 2002). It is not surprising that many science teachers have misconceptions about Earth Science and pass these to their pupils (see King, 2000). These and similar data showed UKOOA that Earth Science was often not well taught. UKOOA reasons that, to make informed environmental decisions later in life, pupils need a sound science foundation.

As part of its 'sustainability strategy', UKOOA has invested in the citizens of the future by backing ESEU activities. It wants to see a well-informed population able to debate the issues on the basis of accurate knowledge and understanding. ■



School visit

If you would like ESEU to visit a school near you, then ask a science teacher there to contact the ESEU administrator, Bernadette Callan, ESEU, Education Department, Keele University, Staffordshire ST5 5BG, 01782 584437, eseu@keele.ac.uk or contact us through the ESEU website that also contains details of all ESEU activities, www.earthscienceeducation.com. You can get a set of ESEU flyers to pass on to your local schools by contacting Bernadette as well. Help us to bring Earth Science to life for children in your area by publicising ESEU activities. Let ESEU revitalise your local science teachers, motivating and enthusing them and helping them to increase their understanding of the planet on which they live.

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Rock'n'rain –



Norman Moles,

School of the Environment, University of Brighton

Richard Moles,

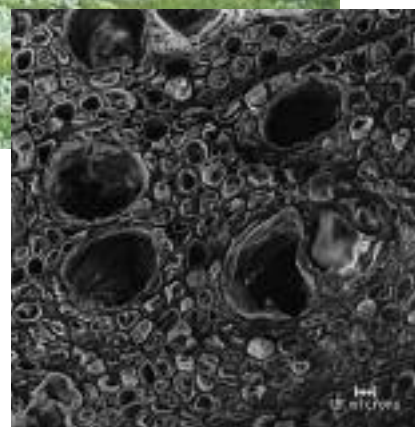
Chemical & Environmental Sciences, University of Limerick

...on a fascinatingly barren piece of Ireland

Famous for its wonderful limestone landscape and its remarkably diverse flora, the Burren is an essential item on the itinerary of many visitors to Ireland. Its hills comprise massive and bedded limestone that was originally deposited in the warm Carboniferous seas. If the weather is kind, visitors cannot fail to be impressed by the stark, glacially sculpted hills, the limestone pavements among which colourful flowers hide in grykes, the patches of grassland and hazel scrub, and the shimmering, ephemeral turloughs with their reed and sedge beds. However the landscape is frequently cloaked in rain clouds and visitors often leave disappointed.

The Burren's high rainfall (1,200-2,000 mm/year) makes it unique among Europe's karstic upland landscapes and is an important factor in the origin of its distinctive landscape and plant diversity. Vegetation is restricted to areas of gentle slope on hilltops, beneath limestone scarps, in dolines (solution hollows) and on drumlin landforms (glacial deposits). Erosion has stripped soil from the hillsides leaving bare limestone pavements and rubble-strewn areas. However, remnants of soil found preserved beneath ancient drystone walls and dolmens (burial chambers) attest to formerly extensive soil and vegetation cover, and hint at Man's actions in contributing to the development of this 'barren' landscape. On the flank of Knockanes, we found fragments of wood charcoal preserved under a thick cover of slumped soil, indicating that the hazel scrub was burnt and the unprotected soil slid downslope

Above: Sliabh Rua (right) and Knockanes (left) from Mullach Mór.



Above: SEM image of Bronze Age hazelwood charcoal from Knockanes. (by permission Geographical Society of Ireland)

during the next heavy rainfall. Radiocarbon dating of the charcoal revealed that this fire occurred 3,300 years ago. So Bronze Age farmers were responsible for at least some (and perhaps much) of the deforestation and soil erosion in the Burren.

Soil erosion is an ongoing concern, particularly where trampling by grazing animals or humans damages grassland and exposes the underlying thin soils. This is one reason for abandonment of plans to build an interpretative centre near Mullach Mór in the Burren National Park.

But localized soil erosion actually promotes floral diversity. Rainwater, made slightly acidic by organic matter, dissolves limestone particles in the soil leaving a sandy residue of silicate material. Rainwash moves this sandy soil downslope where it accumulates in hollows, forming 'acid' soils that are favoured by calcium-hating plants such as heathers and primrose. This process also exposes fresh calcareous subsoil on the steeper slopes, so that calcium-loving plants thrive in the grassland on drumlin flanks.

Tell-tale silicates

Silicate mineral and rock particles comprise less than one-tenth of the volume of unweathered glacial till, but they tell an interesting story. In addition to chert derived from the local limestone and quartz from mineral veins, there are fragments of granite, schist and sandstone that must have come from outside the Burren area.



sis of Burren's biodiversity



Top: Feral goats on limestone pavement. Above: grass-covered drumlin landforms south-east of Sliabh Rua, showing Mullach Mór at far right. Right: a Burren grassland plant, the flowering stonecrop.

All photos except the SEM image by Norman and Richard Moles



The granite and schist are from Galway – Connemara, over 30km north and north-west of Mullach Mór, and the sandstone may be from the Slieve Aughty Mountains, a similar distance to the east and north-east. Were it not for this glacial smearing of far-travelled silicate material across the Burren limestones, the soils would probably have been thinner and the floral diversity poorer.

In the Mullach Mór area, glacial smearing has also dispersed silicate material of local derivation – specifically shale – that occurs in two small outcrops between Knockanes and Sliabh Rua. The shale occurs within a conglomerate of shale and limestone that may have formed as a debris flow extending across the Carboniferous seabed. On the outcrops of shaly conglomerate, and for some distance down-ice to the south, are soils rich in clay derived by weathering of the shale. These soils support heather and other plants that like the water-saturated, acid conditions. Small patches, a few metres to 10m across, of identical soil and vegetation are found farther south from the outcrops. We speculate that these patches are the weathered remains of boulders of the shaly conglomerate. The boulders were transported intact within the ice sheet and dumped as erratics on the land surface. Again, a combination of geology, glaciation and weathering has produced a marked spatial heterogeneity (variation) in soil composition and in associated vegetation.

So, if the westerly gales and horizontal rain lash you during your visit to western Ireland's most famed landscape, be consoled that you are witnessing the elements that have shaped the landscape and that have generated its rich



Pictures at an EXHIBITION

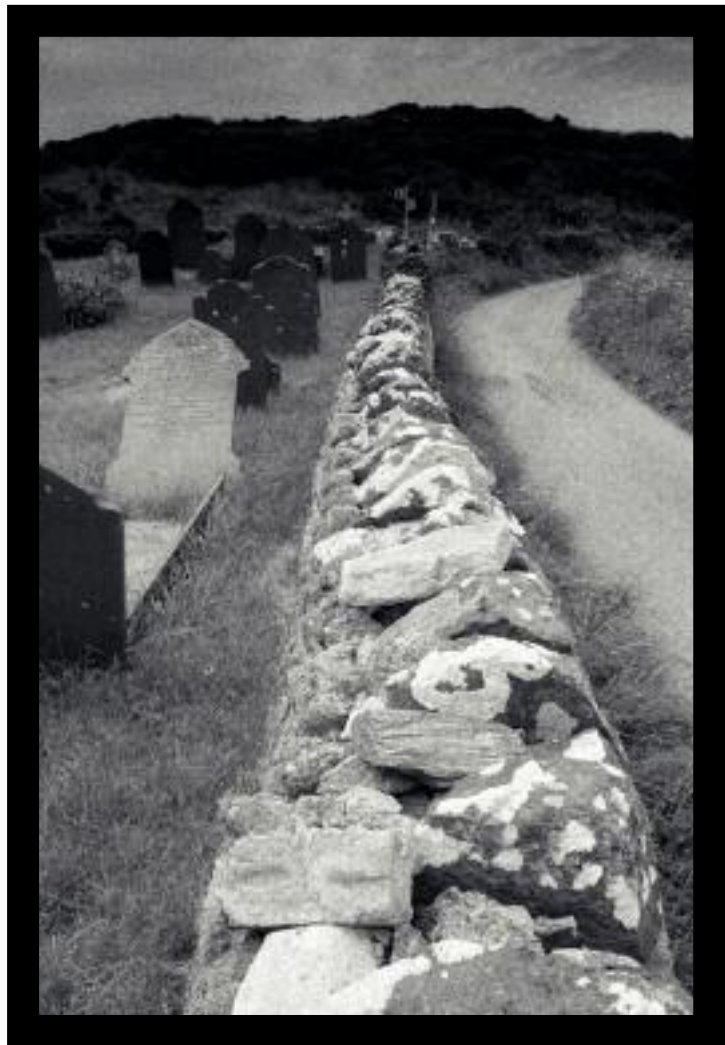
Rhoscolyn Rocks and Landscape is the prosaic title of an exhibition of a set of 41 quite magnificent and beautifully framed photographs of elements of the landscape of just one small part of Anglesey. Stewart Campbell, the Managing Editor of *Earth Heritage*, has taken the photography of rocks from and in the landscape into a highly artistic dimension. The exceptional images were hand-printed on fine art cartridge paper by Glyn Davies, a professional photographer and lecturer in photographic studies at the University of Wales at Bangor. The exceptional studies were executed by Stewart over a two-year period while completing a project for a University course, but as the lecturer said at the launch of the exhibition the pupil has become the master. Most professionals in the arts, whatever their discipline, have a particular 'freedom' of expression. Marry that quality of expression to the professional eye of another specialist, in this case an experienced Earth Scientist, and the result is stunningly original. It is extremely hard to put into words the ethereal quality of some of the images, the spectral shimmer of others, the vibrancy of many and the sheer beauty of most. In one sense it matters little where the images were taken as their beauty speaks for itself. It also matters little what they portray and no geological explanation is required, although it may prove useful to know where Rhoscolyn is, if only to allow those interested to share the potential of that area.

The following two pages give a taste of some of Stewart's exhibition photography.

– **Mick Stanley,**
Geodiversity Consulting

■ During a two week exhibition at Penrhyn Castle, Bangor, orders were placed for more than two dozen prints from Stewart's work, with proceeds after production expenses going to the Gwynedd and Môn RIGS Group, for which a number of display boards were also produced.





Playing it safe on contaminated sites



Anna Wetherell,
*Senior Geologist and
Waste Policy Advisor, English Nature*

Lady's Rake, a contaminated mine in Upper Teesdale SSSI, County Durham.

Photo by Mick Murphy/English Nature

In April 2000, Part IIA of the Environmental Protection Act 1990 introduced a new regulatory regime for identifying and remediating contaminated land, with duties for local authorities and the Environment Agency in particular. All well and good – finally old industrial sites will have to be assessed for contaminants, and the problems dealt with.

Unfortunately the sites include old mines and a number of SSSIs that are of interest for their mineralogy, and often rare assemblages of plants (e.g. Calaminarian grassland, a candidate European Special Area of Conservation habitat). What will happen to them? The problems include pollution of watercourses from mine adits, with possible watercourse contamination, dust, or incidental ingestion of material (e.g. barium and lead) from mine dumps. The standard practices for dealing with contaminated land and material are not particularly appropriate for conservation of the geological resource. Capping the site with clay buries the interest. Removing the contaminated material to landfill removes the minerals and plants with it. Chemical or biological remediation can also destroy the interest.

Some conservation work has been done.

Earth Heritage's predecessor, Earth Science Conservation, reported on work at Snailbeach Mine, Shropshire, in July 1992. Here efforts were made to conserve parts of the interest, while also making the site safe and accessible. Some of you may also be aware of the research and practical work being carried out in Cornwall, to remediate the legacy of tin mining. But how much of a problem is there, and what solutions can we find?

To answer some of the questions, English Nature instigated a pilot research project over the winter of 2002/03. Wardell Armstrong looked at mineralogical SSSIs in predominantly lead-zinc-fluorite-barites deposits of the North Pennine Ore Field. This area consists of a suite of sites on the Alston and Askrigg Blocks, reflecting the complex mineralogy influenced by the Caledonian Weardale granite, the Whin Sill and deep-basin brines. The sites include mine dumps, outcrops of minerals, and old mine workings.

The sites were investigated for possible contaminants and samples were collected of soil and surface material, and from watercourses. The sites were also assessed for how easily accessible and potentially well used they were. Potential impacts on human health will partly depend on how regularly the sites are used. Thankfully

most sites were fairly remote, so any potential contaminants were considered low risk due to infrequent and irregular access. Warning signs could be put in place to raise awareness with visitors – the main concern being to avoid eating your sandwiches while sitting on the mine dumps! We are now aware that there may be issues on some sites, and we will be working with the relevant local authority to find the best solutions. However, in comparison with many ex-industrial sites in the North-East, these few sites are unlikely to be of major concern.

As for the next stage, we need to look more widely at other SSSIs. English Nature is planning a desk-based survey of the remaining sites, using knowledge of the mineralogy and geology of the areas, past or current mining industry, and any recorded pollution or water-quality issues. It is disconcerting to think that some of our SSSIs may be a hazard, but hopefully we will be able to manage the risk without losing the special scientific interest. The research carried out will be published as part of English Nature's Research Report series. Should anyone have any thoughts or comments on this issue, contact:

Anna Wetherell,
Tel: 01733 455588, e-mail:
anna.wetherell@english-nature.org.uk

THE GREAT ORME –

A delicate balancing act...

Overlooking Llandudno and the North Wales coast, the Great Orme is a geological and wildlife treasure, a mining history gem and a honeypot that draws half a million visitors every year. How do you ensure that these very special attributes are conserved in the best way possible but still allow people continue to enjoy themselves?

Earth Heritage invited two perspectives of the Orme and how this happens. **RAYMOND ROBERTS** of the Countryside Council for Wales looks at the geology and wildlife. **GREAT ORME MINES** looks at the mineralogy and industrial archaeology.

Part of the limestone pavement RIGS, with the summit Complex in the far distance.

Photo by Stewart Campbell



The Great Orme holds two Geological Conservation Review (GCR) sites, two registered RIGS and several other proposed RIGS. Its geology includes Carboniferous limestone stratigraphy and fossils, copper-dolomite mineralization, limestone pavement and karstic features, soil sections and important Quaternary landforms and deposits. Throw into this equation habitats and creatures of national and European importance, Bronze Age mines of international importance, Scheduled Ancient Monuments, half a million visitors per year and, in site management terms, there's quite a balancing act to perform!

Geological highlights

The Great Orme has two GCR sites – one for the mineralization found at the Great Orme Copper Mines, and one for stratigraphical (Dinantian) features found throughout the headland. One of the best known Carboniferous limestone fossil sites in Britain, this classic Dinantian locality provides an almost complete profile through the Lower Carboniferous of North Wales. A syncline runs north-east to south-west, exposing the geological sequence in steep coastal cliffs, inland natural outcrops, road sections and disused quarries. The limestone records cyclical changes from marine to shoreline, or near-shoreline conditions. These show up in a series of massive and more rubbly, thinly bedded limestones. The different rates at which these materials have eroded have created the Great Orme's distinctive 'stepped' topography.

The summit of the Great Orme holds the largest areas of coastal limestone pavement in Wales. The biggest is a registered RIGS. The pavements display a range of solution features, including deep grykes and large clints, and a massive solution hollow with associated radial karren. Several massive limestone boulders were perhaps dumped by glacial ice. The coastal sites contrast with more heavily vegetated inland sites. Some of the Orme's soil sections, mass movement and Quaternary features may also prove worthy of RIGS status.

Plants and animals

The Great Orme's lime-loving grassland

communities, limestone heath and maritime cliff vegetation are of high botanical value. Moths, butterflies and a large grassland invertebrate assemblage are widespread. The coastal cliffs, rock pools and intertidal areas support nationally scarce animals and algae, most typically associated with rock pool, cave and limestone rock habitats. The sea cliffs hold many breeding sea birds.

Conservation Status

With the variety of important features comes a myriad of conservation designations! The main geological and biological features are notified as Sites of Special Scientific Interest (SSSI). Some of the biological features even warrant European protection within a Special Area of Conservation (SAC). Geological features of regional value are registered as RIGS, while the historical and archaeological features are designated as Scheduled Ancient Monuments. Local Nature Reserve, Country Park and Heritage Coast designations provide further management levels. The range of designations means that numerous individuals and organisations are involved in managing and protecting the site.

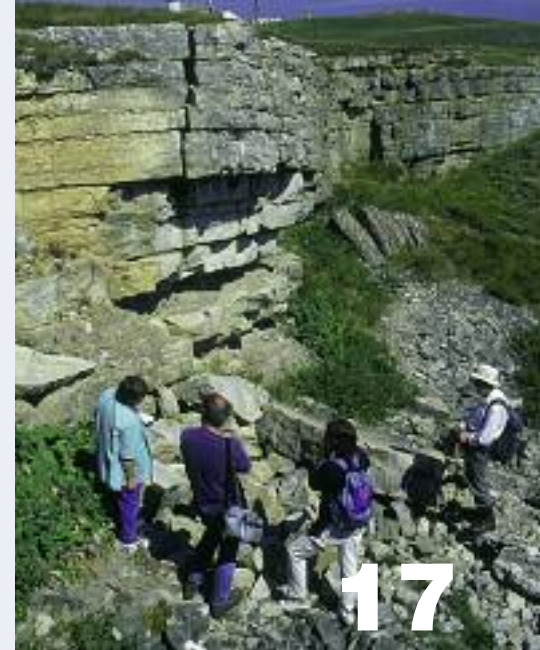
Co-operation to conserve the geological interest

BISHOP'S QUARRY, near the summit of the Great Orme's Head, is much used by

continued overleaf

A field party keeps well clear of unstable cliff faces in Bishop's Quarry. These faces have now been made safe.

Photo by Stewart Campbell, CCW



Managing and informing visitors

More than half a million people visit the Great Orme every year. Visitors come to walk, rock climb, birdwatch, orienteer – or simply to enjoy the scenery. Much of the summit of the Great Orme is managed as a Country Park and Local Nature Reserve by Conwy Countryside Services, and in 1983 the Great Orme Country Park Visitor Centre was opened near the summit. The centre includes a gift shop, run by the North Wales Wildlife Trust. Much of the modern interpretative material tells visitors about the importance of the site and the need to protect it.

Although day-to-day management is done by the Countryside Service, through the Great Orme Working Party its staff work closely with private enterprises (e.g. the Great Orme Mines, Great Orme Tramway, cafés etc.) and statutory organisations such as CCW and CADW (Welsh Historic Monuments) to ensure that the many issues that arise are handled efficiently and effectively.

from previous page

schools who study the superb brachiopod, coral and other fossils. It is also vital to researchers investigating the upper parts of the Great Orme Carboniferous succession.

Due to the large numbers of visitors to the quarry, Conwy County Borough Council commissioned a safety inspection of the quarry faces by Mott MacDonald and found significant instability problems. The engineers recommended a variety of solutions, including total public exclusion by fencing, permanent stabilising measures (possibly rock netting) and periodic safety works (manual scaling to remove unstable material). Both the local authority and CCW recognised the site's education and research value and wanted access maintained, so manual scaling was agreed. The fossil-rich 'waste' rock generated by the work is now on the quarry floor away from the faces, allowing visiting parties to collect fossils safely.

Although safety works can damage geological features, the consultation process afforded by the Wildlife and Countryside Act 1981 (as amended by the CROW Act 2000) has worked well here to meet key safety requirements and allow continued access to the geology.

THE GREAT ORME COPPER MINES

is a major success. Twenty five years ago the mine was an eyesore of bare spoil and abandoned cars. Today it epitomises co-

operation. It is a major tourist attraction and, through continued excavations, is improving both the geological and archaeological features (see next article). When re-excavation of the archaeological interests of the old mines began, it was important to ensure that the work did not conflict with CCW's conservation aims for the SSSI-notified Dinantian exposures in the mines area. The result was quite the contrary: the new exposures provided better sections and improved the Dinantian site! Mineralogical research has also benefited.

Prior to the excavations, it was not readily possible to study the mineralization *in situ*. Now, the Great Orme Mines provides the UK's only example of a copper-dolomite deposit. Further excavations and research should add to our knowledge of the site's geology and mining history, particularly its significance to Bronze Age society.

The future?

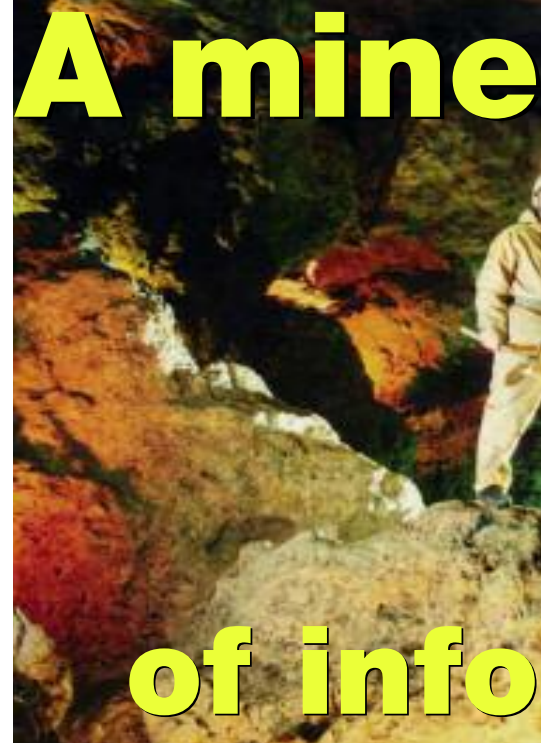
The Great Orme Mines and the Bishop's Quarry are just two examples of co-operation and 'joined-up' thinking on the Great Orme. Continued co-operation is essential to ensure that it remains a flagship for both nature conservation and our historical and pre-historical heritage. ■

– **Raymond Roberts,**
Countryside Council for Wales



The summit of the Great Orme seen from the cable car. Another mode of access for visitors - the Tramway - is seen to the left of the suspended car.

Photo by Stewart Campbell



The prehistoric copper mines on the Great Orme are a unique industrial complex of international importance.

They are evidence for some of the earliest and most extensive metal mining in Europe. Conservatively, mining covered an area in excess of 2,400m², incorporating 6 km of labyrinthine passages running as far down as 70m. The mines appear to have been worked throughout the Bronze Age, and again from the 17th to late 19th centuries.

Mineralogy

The mineralogy on the Great Orme is relatively simple – primary chalcopyrite as veins, nodules and crystals lining cavities. Near the surface, this has been oxidised to brown goethite, the green carbonate malachite and minor blue azurite. Native copper has been reported and extensive areas are stained black with manganese oxides. Rare cobalt/nickel arsenates and veins of galena also occur. The mineralisation is intimately associated with dolomitised limestone, the host rock being brown, hard and crystalline, with typical shrinkage cavities. However, close to the ore veins, the dolomite is often 'rotted' and soft. This, together with the interbedded layers of softer mudstone, is probably what provided such ready access for the prehistoric miners, who would have been attracted by the striking green pigmentation of the malachite.

Mining history

In the 19th Century this ore deposit was exploited to below sea level through a



rmation

Left: Tony Hammond of Great Orme Mines in the Prehistoric chamber.
Right: Nick Jowett in one of the smaller tunnels!

All photos by Great Orme Mines

management.

Over the last 12 years, the mines have been developed above and below ground as an archaeological tourist site. At the surface, a prehistoric opencast, some 25m by 45m in area and up to 20m deep, has been exhumed from beneath 100,000 tons of 19th century spoil. Bedrock is exposed to the east and along the southern rim beyond which it descends more than 13m in what must have been a scarp face. Underground, a 200m route has been developed by limited excavation and enlargement of prehistoric workings. It enters and leaves through original openings in the southern scarp face and reaches an enlarged window looking into the major chamber north of Vivian's shaft which has also been cleared of spoil. A purpose-built visitor centre, including a café/shop and audiovisual unit, rounds off current facilities.

In the late 1970s, a local mining archaeologist suggested that the mines were much older than previously suggested, and in 1985 the Great Orme



Exploration Society was established to investigate. The WDA was key in bringing the project to reality while the Gwynedd Archaeological Trust kept a watching brief on the site.

The importance of the Great Orme Mines has attracted support from organisations that include the British Museum and the Smithsonian Institute, and work would not have been possible without the support of local, district and county councils, the Countryside Council for Wales, several universities and the international mining giant, Minorco.

Great Orme Mines has set out to ensure that work at the site and the visitor centre is sympathetic to its archaeology and to the environment while all the time increasing public knowledge of Bronze Age matters. Access for 30,000 visitors a year has been designed to provide maximum information without intruding on the structure of the mines. The interpretative centre is growing,

in line with progressive excavation on the surface and underground. Displays of artefacts and the audio-visual presentation are soon to be complemented by a reconstructed Bronze Age village.

Great Orme Mines has transformed a derelict area of the Great Orme Country Park into a successful tourist and educational enterprise. In doing so, it has revealed one of the major archaeological mining sites in the Western World while helping to enhance the features of the



Contact:
Nick Jowett,
Great Orme Mines

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Left: The site as it was in 1987 and, above, as it is today.

Below: One of 3,500 stone hammers found at the site. This one is approximately 28cm tall.



– hammering out a future?

This one-day conference at the University of Salford aimed 'to discuss the different aspects of mineral collecting, the best way of conserving the available mineral resource for future use by all interest groups and to open a debate rather than attempt to reach solutions'.

Bryan Young, Regional Geologist for Northern England, started by stressing the importance of minerals to the nation's heritage. He noted that most sites were multi-interest although usually geologists generally and mineralogists specifically were not consulted about anything relating to geology or minerals; the inference being that other disciplines knew all about the geology, which is patently untrue.

He told of the total extraction of a vein to keep it preserved for study and safe from destruction by indiscriminate collectors. He decried the processing of large amounts of ore to acquire micro-mounts, thereby destroying the context and history of the mineralisation. It is this practice that has necessitated the introduction of licensed collecting on the Caldbeck Fells, Cumbria – something that may have to be extended to other areas unless a code of conduct adhered

Mick Stanley,
Geodiversity Consulting

to by all collectors is introduced.

Colin Prosser from **English Nature** described the current conservation legislation and management issues relating to mineral sites. Although collecting is not a major concern on most geological sites, it is a significant issue on mineralogical sites that tend to occur as dumps or veins and are finite in nature. Colin called for the sustainable management of mineralogical sites, based around an agreed approach to responsible mineral collecting. Drawing on experience

gained in the management of fossil collecting, an approach that involves landowners, takes account of different types of designations, and involves all stakeholders was advocated. English Nature will be producing a policy position statement on mineral collecting in the near future.

Don Edwards gave the view of an experienced dealer trading in minerals from the former Soviet block and the supply of fine minerals specimens from individuals working in the mining industry. He suggested a system of notification and state marketing for quality minerals, used in the USSR, should be introduced in Britain as he saw the main threats to minerals being extractive industries, where saved/stolen minerals were insignificant in the total extracted.

Aggregates Levy Sustainability Fund

One year on from the launch of English Nature's Aggregates Levy Sustainability Fund Grants Scheme, all available funds have been committed and projects are well on their way to delivering their objectives within the current financial year. English Nature has supported 107 projects covering geodiversity, biodiversity or a combination of both.

Thirty two of these projects, totalling around £2million, are tackling aspects of geological conservation and geodiversity.

At the most recent meeting of English Nature's grants panel, in January, available funds did not allow grants to be made to all worthwhile projects. Tough decisions were made about which to fund and which

to re-consider if funds are forthcoming in the future. The panel allocated the final tranche to projects which were strongly linked to the scheme's objectives and clearly deliverable by March 2004. The Sustainability Fund is only guaranteed until April 2004.

Future opportunities for projects now depend on HM Treasury and DEFRA

The projects are wide ranging in geological timescale, geographical spread, support required and community involvement, as this random list indicates:

- The North Pennines AONB Geodiversity Action Plan
- Brown End Quarry Visitor Implementation Project, Staffordshire
- A walk into history - renovating the Swanscombe Skull Site, Kent
- RIGS recording, designation and GIS development, Hereford and Worcester
- A museum resource for Shropshire
- Geodiversity in Staffordshire
- Conserving geodiversity in an aggregates site, Oxfordshire
- Rescue excavation of a giant fossil fish, Cambridgeshire



Excavation of giant fish fossil at King's Dyke, Peterborough.

Photos by Dave Martill/University of Portsmouth



Weathering and local authorities/ regional planning bodies were the other threats.

Roy Starkey, a 'professional' amateur reviewed the role of the amateur collector over 40 years, noting the burgeoning of interest in the 1970s. The last 20 years has seen increasingly improved access to sites. He estimated that of about 2,000 collectors, only 300 were serious and only 100 of those in need of education on how to collect responsibly. Serious dialogue is required to reach these. Mineralogy needs amateurs for their continuing scientific input and their recycling of material through buying and selling; the main collections in British museums are largely from amateurs. He finally posed an interesting question... Why not have a mineralogical equivalent of the Coal Measure heaps at Kilmersdon where the public can search for minerals?

Bob Symes felt that academics took a macro perspective of minerals in the Earth's crust, but he noted the dearth of scientific enquiry by many collectors and urged research of collections to identify if mantle material is represented in Britain.

Brian Jackson of the **National Museums of Scotland** justified having mineral collections by outlining the museum goals of access – safeguarding for posterity and the promotion of the educational and intellectual value of specimens. He argued that collections need to grow with a dynamic acquisitions policy to

reflect social and scientific development. He pointed to the Tucson mineral show where 47,000 visitors purchased the equivalent of £75M worth of specimens. Museums in Britain did not have that purchasing power and relied on donations and field collection, as this was often the best use of available resources. Laboratory research was the best science and it was best to remove the minerals from the ground to preserve them. He argued that exposing more rock made more specimens available and private collectors were at the forefront of mineral conservation by collecting! Amazingly, explosives and power tools were advocated for mineral extraction.

Bob Reekie looked at the disappearance of the industrial archaeology of mineral mining in Scotland over the past 30 years and the attempt by independent trusts to preserve buildings and processes, especially at Leadhills and Wanlockhead in Lanarkshire.

The final speaker was **Jon Brookes** of the **National Trust**, a land manager of the West Penwith Estate on Land's End, Cornwall. He said the organisation owned 300,000 hectares and had 3,000,000 members, with the vision statement – For ever, for everyone. His approach was working with the local community through an education programme to introduce minerals to schoolchildren and preserving mine shafts with 'Cornish hedges' around the openings, all 140 of them. The NT

is managing a culture change, all work is approached holistically and it no longer acts as a countryside policeman as byelaws effectively control mineral collecting; it is the same rule for plants, rocks, fossils and minerals – No collecting. There is no defined NT policy on minerals, but one will eventually emerge.

The final discussion session reached some conclusions including the fact that the mineral resource is every aspect, from site to museum to the people involved. The value was accepted, but a dichotomy exists between the two schools of thought – preservation or conservation? Threats were seen as relative and the scale of collecting related to the finite nature of a resource, but most were because of a lack of joined-up thinking and consultation.

Arguably the main threat to the conservation of mineral sites comes from ignorance of the finite nature of the resource, the lack of awareness of the need to conserve sites and to preserve specimens in museum collections. Other threats clearly also come from removal by quarrying and mining, the conservation of specific animal species, for example bats, and the landscaping and designation of sites as Ancient Monuments, thereby sterilising them as places for research, which usually means removing specimens for study, or simply obscuring a deposit. Speaker after speaker stressed the importance of minerals to our civilised way of life and that collecting is fundamental to mineralogical research, educational use, commercial exploitation and for purely aesthetics, but that indiscriminate collecting can destroy a mineralogical site.

If a resource cannot be grown it has to be mined or quarried and, of course, rocks are agglomerations of minerals and are essential to sustain the way we live. But not only is there little joined-up thinking with most restoration schemes, but the accepted conservation practice of not removing by picking plants or harming a multitude of protected animals is not applied to most rocks, minerals and fossils unless they are on National Trust land or a SSSI. Birds have been protected since the 1890s, why not mineral species?

Although 48 people attended, there were no politicians, no planners, no archaeologists, no lawyers and no-one representing the extractive industries, wildlife trusts or English Heritage. This was not for the lack of trying by English Nature, the organisers with the Russell Society and the Geoconservation Commission. The real problem is that Earth Scientists now need to consider staging meetings specifically for these audiences. ■

A report of the conference will be published as an English Nature research report and will

A great success, but what is ahead?

decisions over the Sustainability Fund, in terms of both objectives and distribution. At present DEFRA is developing a consultation framework and collating project and financial information from all distributing bodies. A full consultation is expected this summer, and comment on the future of the fund should be in the Chancellor's pre-budget report in November.

If English Nature is successful in securing future funding, we shall call for applications as soon as is practical. Modifications to the scheme could well be made in the light of: DEFRA consultation responses; comments made directly to English Nature by stakeholders and applicants; changing priorities in nature conservation. However we anticipate that geological conservation and biodiversity will remain core objectives.

English Nature wishes to thank all applicants for their patience, and determination, during the development of the Sustainability Fund Grants Scheme.

An update on future of the fund will be given in the January 2004 issue of *Earth*

Those seeking further information on the DEFRA consultation process, budget announcements and general developments may find the following web addresses useful later in the year:

English Nature's web site for developments on any new grant scheme.

www.english-nature.org.uk/

DEFRA web site. The Environmental Protection, Waste and Recycling Division currently co-ordinates the Sustainability Fund distribution.

www.defra.gov.uk/

HM Treasury for briefing on the pre-budget report.

www.hm-treasury.gov.uk/

Heritage. ■

Natalie Bennett,
English Nature

Cynthia Burek,

UKRIGS Geoconservation Association

asks how we can prevent collections being thoughtlessly discarded.

Time to take responsibility for collections

The growth of geology as a natural science owes a huge amount to people's collecting habits. But the painstaking labour and documentation that individuals put into their collections can end in ultimate disappointment: after their deaths, the collections can simply disappear and become lost to science.

Take the stories of Etheldred Benett and Catherine Raisin. They lived many years apart but both expressed doubts about the long-term futures of their collections - and their concerns proved well-founded.

Etheldred Benett (1776-1845) was the authority on Wiltshire fossil sponges and mollusca and an avid collector for over 34 years. In 1813, the scientific importance of her collection was recognised when it was illustrated in Sowerby's *Mineral Conchology*. Etheldred contributed the second highest number of specimens (41) within the seven volumes.

She gave her ideas and fossil collection freely to museums, including one to the St Petersburg Museum. Following her 'gift' of fossils to the Czar, the Emperor of Russia, assuming she was a man because of her first name, conferred on her an Honorary Doctorate of Civil Law at St Petersburg University. This was at a time

when women were not even admitted into higher education institutions.

Etheldred Benett was meticulous and precise in her collecting and could not abide others who did not share her high regard for cataloguing and curating. On her death, Miss Benett's collection of thousands of labelled Jurassic and Cretaceous fossil bryozoa and mollusca was sold to a collector and taken to the USA. Most of it was bought by former Englishman and physician, Thomas Wilson of Newark,

Delaware, and subsequently donated to the Philadelphia Academy of Natural Science between 1848 and 1852. For several years, it was thought to be lost. However, it eventually came to light again at the Academy of Natural Sciences in Philadelphia, and was re-introduced to the scientific community in 1989 by Hugh Torrens and colleagues. The collection contains some of the first fossil bivalves to

have preserved soft parts. There are also collections in Leeds City Museums, the Warwickshire Museum and the Yorkshire Museum. Interestingly, two separate gifts are recorded in the Leeds accession

registers, one of 'over 50' specimens in 1845 the year of her death and the second of '3000' specimens in 1846, the year after she died. They are recorded as the collections of Miss Etheldreda Bennett, note the different spelling. The collection in the Warwickshire Museum, is only of 23 specimens and the collector is

recorded as Miss Ethelred Bennett; again another interpretation of her first name. The collection in the Yorkshire Museum was given in 1831 and is a 'large series' that has been interpreted as 500.

She is listed as associated collector in several other collections in the Warwickshire Museum; her fossil material may well be represented in other

A fossil sponge, *Alcyonia*, from Warminster Common, illustrated by Etheldred Benett and her to the Society of 1816, along with stratigraphical location in the Formation. The illustrations are from a manuscript.



The only known image of Etheldred Benett



ollections

Catherine Raisin (1855-1945) was born 10 years after Etheldred Benett died. She became an expert on serpentines and was an avid collector, working at University College, London. In 1890 she became Head of Geology at Bedford College, London, and the following year was appointed Head of Botany too.

Catherine's extensive collection of over 270 specimens of serpentines from Anglesey, the Vosges Mountains and the Brenner Pass (she personally collected all of them) was a great source of pride to her and represented a significant teaching and research aid. She wrote at least 24 papers based on her collection and observations. Despite this, there was a distinct lack of concern in Bedford College about the future of the collection. Anxious to know that it would be cared for after her death, Catherine wrote to the College at least three times to ask what would happen to the serpentines, but received a reply which made difficult stipulations about access to the collection. Where is that collection now that Bedford College no longer exists? Sadly, no-one seems to know. Certainly she does not appear in the Fenscore Natural Science database of collections once held at Bedford College and Royal Holloway, which took over from it, can find no specific references to her specimens. The serpentines could

easily have been subsumed into the general rock collections over the years, as so often happens when collections are not continuously curated.

Both Etheldred Benett and Catherine Raisin assembled extensive collections of specimens that were valuable resources.

However, neither woman could control or influence the destiny of her collection after she had died.

The value of collections such as these is poorly regarded by most decision makers and there are insufficient geological curators to care for the large number of collections residing in British museums.

Perhaps it is time we looked at the true worth of collections and took forward the policy of preservation. After all, the Earth does this for us as a matter of course in the fossilization process. We should be charged with a responsibility to do the same for future generations. Sustainable

Women make a mark

The growth of geology as a natural science owes its beginnings to the collecting habits of the leisured classes. Collections were assembled mainly by men, but several women have achieved some fame too.

Elizabeth Anderson, later to become Mrs Gray (1831-1924), collected fossils for many years in Scotland. Her collection was sold to the British Museum in 1920, when she was 88. Mary Anning (1799-1846) is perhaps the most famous female fossil collector. She spent 40 years of her relatively short life collecting and died at the age of 46. Elizabeth Carne (1817-1873) built and ran a mineral museum in Penzance, Cornwall, and the Philpott sisters did likewise in Lyme Regis.

Collections database

Natural Science collections, namely geology, botany and zoology, in museums in Britain are recorded in a database managed by the Manchester Museum (University) on behalf of FENSCORE, the Federation of Natural Science Collection Research first set up in 1980. The site is www.fenscore.man.ac.uk, where a search for a collector, taxon, geological period, geographical area etc. is quick and rewarding. Also try the museum collections web site on www.cornucopia.org.uk managed by Resource, the Council for Museums, Libraries and Archives, where eventually all collections in Britain's 1,800 registered museums will be listed.

- Mick Stanley, Geodiversity Consulting

Below: Catherine Raisin and colleagues taken sometime between 1898 and 1906. Catherine is on the extreme right of the back row. Among others in the picture is Ethel Hurlbatt (front row second left), who was Principal of Bedford College.

Photo from Archives, Royal Holloway, University of London ref BC PH1/1



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development of collections is needed now. Thanks to John Wright, Curator, Royal Holloway Geology Department, and Archives at RHBNC for detailed information for this article.

Stuart Monro,
Our Dynamic Earth

Keeping EA



'The Walking with Dinosaurs' exhibition extended the story of Our Dynamic Earth (above). The imposing facade of the building housing Our Dynamic Earth says little about what is inside (main picture).

Photos by Dynamic Earth

Since the new Millennium, the UK has made the biggest investment in getting science into the public arena since the Great Exhibition of 1851. In Scotland alone, the Millennium Commission has invested £54,579,037 in science-based visitor attractions and at least a similar amount of matching funding was raised.

What has emerged from that investment has been a network of science and discovery centres which cover the main areas of science and technology. The biggest centre, the Glasgow Science Centre, communicates many aspects of science and features a space theatre, a virtual science theatre and an IMAX cinema. Sensation in Dundee focuses on the science around the five senses and the Big Idea in Irvine celebrates invention. In Aberdeen, Stratosphere has a range of hands-on interactive exhibits related to chemistry, physics, biology, Earth Science and engineering, with a strong focus on what is going on in north-east Scotland. In Edinburgh, the home of James Hutton, there is Our Dynamic Earth, telling the story of Planet Earth.

Communicating science

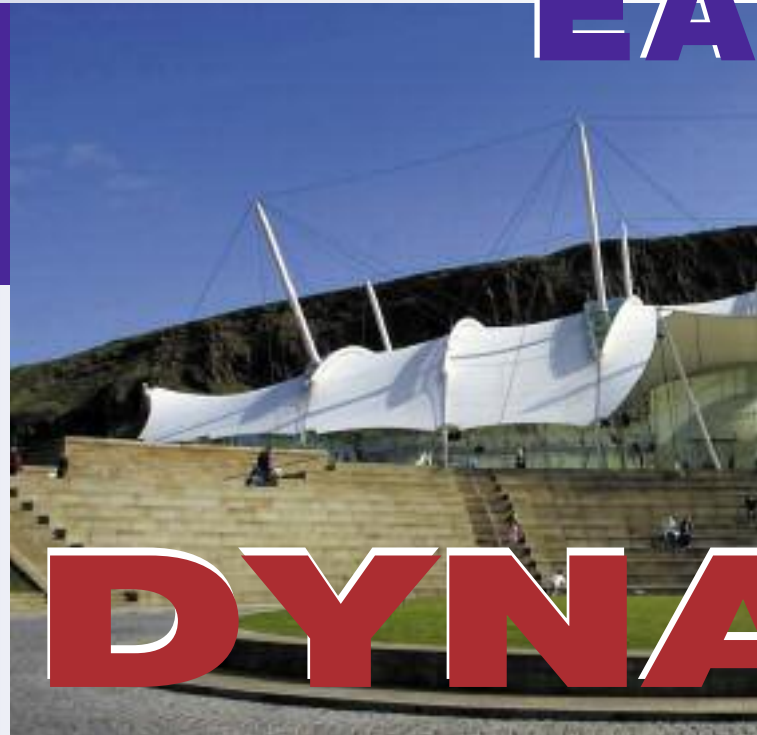
This network is a very effective way of communicating aspects of science to a wide audience; wide in terms of geography and to a widespread age range. These science and discovery centres were set up on the basis of capital funding only and the challenge for all of them is to be sustainable into the future.

Each centre relies on its own activities to generate the necessary revenue to keep going. World-wide, there are very few

centres which are sustained without regular income from external sources, usually local authorities or central government. In the UK, no such funding is available and science and discovery centres stand or fall by their ability to create different income streams. Business plans predict that for each new centre there is a 'honeymoon' period when the visitors from the local area come in large numbers to see and judge what has appeared on their doorstep. Farther down the line and regardless of any initial success, visitor numbers begin to fall in response to familiarity. This is a pattern true of science and discovery centres throughout the UK and the world.

Throughout the evolution of Our Dynamic Earth, and certainly in its future development, there will always be a 'dynamic tension' between the desire to present a scientific story which is accurate, relevant and up-to-date, and the necessity to be commercially viable. This is a challenging tension to manage, yet it is the cornerstone of any success enjoyed by the centre. There is a synergistic relationship between both sides of the business; the science will not be communicated unless Our Dynamic Earth is financially viable, and it will only be financially viable by virtue of a first rate product – a good scientific story.

Our Dynamic Earth has a good scientific



story to tell, but it is now over three years since the exhibition was opened by HM The Queen. The story it tells is as relevant now as it was then – perhaps more so as we learn about global climatic change, and the effects of the utilisation of the Earth's resources. But the local population needs to have a good reason to return to Our Dynamic Earth. The challenge in keeping the exhibition dynamic is in a programme of continual change and development. With limited funds, this ideal is not always easy.

'Walking with Dinosaurs'

During the summer of 2002, visitors could also see the 'Walking with Dinosaurs' exhibition. These exhibits, prepared by the Yorkshire Museum, traced the evolution of the dinosaurs using fossils, fossil replicas, models and audio-visual sequences from the BBC series. It also demonstrated how a major TV series was made, working from the initial finds of the palaeontologists through to the more speculative reconstructions of how these organisms lived and behaved. The exhibition captured the public's imagination, communicated a different aspect of the Dynamic Earth story and increased visitor numbers.

Dynamic EARTH



New technology could radically change the way the story in State of the Earth is communicated.

Photo by Dynamic Earth

Re-developing an exhibition like Our Dynamic Earth is not simple. The overall story remains the same but the technology has changed since the place was originally conceived. There are new ways of demonstrating the processes which have shaped our

some that will be on a smaller scale. All will be driven by the need to tell the story of the planet in a more exciting, innovative, engaging, accessible and up-to-date way.

Looking at Our Dynamic Earth again highlights the fact that, from the outside, the building is imposing and striking but perhaps not very inviting. Nowhere is there an indication that inside is the story of the planet told in a fun way. The exhibition is hidden away within a structural black box.

Other smaller temporary exhibitions on the stratosphere have also helped. The interactive exhibition 'Tour de Force' from the Glasgow Science Centre and individual modules from Techniquest in Cardiff also extended the Dynamic Earth story into other areas of science. The Particle Physics and Astronomy Research Council's travelling exhibition, 'Building the Universe', and 'Wild Water' from the Natural Environment Research Council highlighted current UK research and its relevance to people. In contrast, 'Icy Images' took visitors back to the heroic age of polar exploration and the Scottish National Antarctic Expedition of 1902 to 1904, led by a 35-year-old scientist, William Spiers Bruce, which contributed so much to the understanding of that inhospitable region.

Temporary exhibitions can go some way towards giving people the reason to make a return visit, but fundamentally the need remains to change the existing exhibition. This also provides an opportunity to take stock, to consider what works well, what works less well and how the story of planet Earth can be further developed.

planet. The games technology, beloved of youngsters the world over, now permits an accurate reconstruction of the effects of super-volcanoes or meteorite impacts. However, Our Dynamic Earth is a linear story with a beginning, a middle and an end. Changing the chapters within that story will not be easy.

During summer 2003, the Natural History Museum's Myths and Monsters exhibition will give visitors something new to see.

Opportunity now

Much of the re-development hinges on money and recently there was the very welcome news that the Millennium Commission, the Wellcome Trust and the Wolfson Foundation were to provide a fund, ReDiscover, to help projects like Our Dynamic Earth re-invest in their exhibitions.

We want to grab this opportunity with both hands and phase one of a four-phase re-development programme has been planned and a bid submitted. The master plan envisages changes to most of the existing galleries – some big changes,

The story needs to emerge from its box and permeate the rest of the building. The exterior is less than effective at drawing passers-by. Any re-development will need to make the large amphitheatre area at the front of the building the place where the story begins.

There is also a chapter of the story which is missing. Our Dynamic Earth portrays the 15,000 million years of history since the Big Bang, but what of the future? How will the things we are doing impact on the planet through changes in atmospheric chemistry? What is the likelihood of a super-volcano erupting or a meteorite strike? These things all lie ahead and need to be addressed.

The problems and pitfalls are shared by all the other members of the science and discovery centre network, though sometimes in different ways. However, as is highlighted in the Science Strategy for Scotland, there is a recognised need for a scientifically literate society. Our Dynamic Earth, the science and discovery centre network and the wider scientific community are integral to

Colin Prosser,
Head of Geology,
English Nature,
on a new
publication about
conserving
commercially
excavated sites



World first?

Where would our knowledge of the geological sciences be without information gained from exposures in quarries and pits? What would we know of the geology of inland lowland areas without mineral extraction? How many species of fossils and how many rock types would we never have discovered without quarrying? Where would we educate school and university parties about geology in areas away from mountains or the coast?

Mineral extraction has played, and continues to play, a vital role in facilitating our understanding of geology. The minerals industry provides many of our most important geological localities, a fact reflected in the number of quarries and pits designated as geological SSSIs or RIGS. Although much has been achieved in geological conservation as a result of minerals industry activities, there is scope for more. Some irreplaceable geological features of finite extent, such as limestone pavement, cave-systems, mineral veins or eskers are still occasionally threatened by mineral extraction. Some former quarries or pits of geological interest may also be unnecessarily lost to backfill or to an after-use that does not accommodate geological conservation. In many cases it is simply through a lack of industry understanding about either the geological importance of features, or the opportunities for positive publicity with regard to geological conservation.

While the minerals industry has already done a great deal of good geological conservation, its desire to do more has been hindered by a lack of widely available guidance capturing and promoting good practice.

Now, English Nature, the QPA (Quarry

Products Association) and the Silica and Moulding Sands Association, through our long-established Minerals Industry and Nature Conservation Forum, have produced *'Geodiversity and the minerals industry - conserving our geological heritage'*. The handbook, aimed primarily at the minerals industry, but of relevance to anyone interested in geological conservation, is a follow-up to *'Biodiversity and minerals - extracting the benefits for wildlife'* produced through the Forum in 1999.

This new handbook was launched at the QPA's 2003 quarry showcase annual restoration awards in London, by BBC newscaster Peter Sissons and English Nature's Chief Scientist, Keith Duff. The launch, including a promotional video and live interview on why conservation of our geodiversity is important, was watched by an audience of more than 300 mineral operators, mineral planners, conservationists and MPs, and provided some of the best publicity geological conservation has ever had.

The handbook itself starts by defining geodiversity and its relevance to minerals extractors. It identifies the opportunities for geological conservation during the planning, operating and restoration stages. It concludes with a good practice checklist and identifies key sources of expertise and further information.



Above: Quarries are of immeasurable value to geological conservation for research and education. At Bardon Quarry SSSI, Leicestershire, a school party examines volcanic rocks exposed during quarrying.

Below: From left, Lynda Thompson (Silica and Moulding Sands Association), Keith Duff (English Nature), Simon van der Byl (Quarry Products Association) and Peter Sissons launch the new 'Geodiversity and the minerals industry' handbook.

Photos by Mick Murphy/English Nature (above) and Quarry Products Association



This is probably the first publication in the world addressing this aspect of geological conservation. Its major strength is that it has the backing of the minerals industry and, for once, it is not just supported by the geological conservation community. As such, it should provide a way in for any geological or conservation group to open discussions with their local quarry operators about delivering more geological conservation. It should also help with planning and delivering geological projects funded through the Aggregates Levy Sustainability Fund, which by definition are likely to be focussed on areas in or around quarries. ■

Copies are available free of charge from the Quarry Products Association or from English Nature's Enquiry Service on 01733 455100.

A book to awaken the travel bug

Martin Feely. Galway in Stone – a geological walk in the heart of Galway. Geoscapes Guide No. 1. ISBN 0-954312-0-1 November 2002 €9.

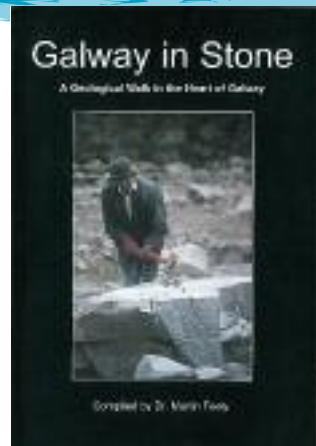
This 48-page full-colour A5 book is lavishly illustrated and written in an accessible style. The images of St Nicholas' Cathedral alone, completed in 1965 and the last major building to be built of stone in Ireland, are sufficient to whet the travel appetite to visit the heart of Galway. The Heritage Council of Ireland is to be congratulated in helping to fund this exploration of the local bedrock geology of Connemara and Galway City discussed in chapter 1, the quarrying history of

dimensional stone itemised in chapter 2, and a walking tour of specific buildings of the City in the largest and final chapter. One expects to see the ubiquitous Norwegian larvikite, Italian travertine, Baltic Brown and Balmoral Red in a city in the British Isles, but it is pleasing to see images of the local and less well-known (in Britain that is) Merlin Black limestone, Leinster granite, Galway granite, Cork Red marble and the multi-layered Connemara marble. Of course the citizens of Truro, Peterborough, Bristol and Worcester will recognise Connemara marble from Streamstown Quarry as it was used to pave the chancels of the cathedrals in those cities in the last quarter of the 19th century.

Equally famous, perhaps, is the Irish black marbles from the limestone quarries at Angliham and Menlough. These were

extensively exported to London, Liverpool, Bristol and Glasgow in the 19th century, to the point where the demand in London was so great that it was traded as London Black.

Mick Stanley,
Geodiversity Consulting

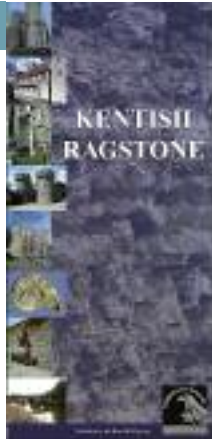


Informative but complex

Kentish Ragstone. Kent RIGS. £1.95

This detailed account of the geology of Kent particularly looks at the links between the local geology and its influence on buildings in the county and wider, from Roman times to the present day. There is a comprehensive description of how Maidstone was 115 million years ago, followed by a description of Kentish ragstone and its uses. There is a mention of the impacts of quarrying and the part the industry has played in historical geology, for example Gideon Mantell's *Iguanodon* which was found in a quarry in Maidstone. The information is extensive, with plenty of pictures and diagrams. The wording may be too complicated for the general public, and due to its content and layout, it would not be a suitable field guide. However, it is well written and informative and there is mention of the Greensand Way, a 108-mile walk from Haslemere to Ham Street.

– Michelle Guthrie, University of Wales, Aberystwyth



Walking through the past – A geological trail for Lower Bangor. Gwynedd and Môn RIGS Group.

An A2 sheet which folds to a third A4, this is the latest in a series of bilingual (Welsh and English) leaflets to illuminate town geology. Easily followed maps take the reader on a 22-stop tour of the town and give pictures and readable details of what lies where. The leaflet is very usable, but the volume of words needed to set out the facts in two languages makes it very busy and initially daunting to the eye. This is an age-old problem for anyone dealing with bilingual publications and a limited budget!

– Seabury Salmon



Diversity in nature. Nordic Council of Ministers.

Excellent pictures of far northern geology and well-ordered text convey the key messages of geodiversity and its relative, biodiversity, in the context of the Nordic countries. Most of the messages transcend international boundaries, so it's a relevant read, well translated from the original Swedish.

– Seabury Salmon

A missed opportunity?

Geology of Fife: a Geological Record in Stone. St Andrews Geological Heritage Project.

This interesting little leaflet describes a geological wall that has been built at St Andrews in Fife. The wall, overlooking the beach, contains a wide variety of rocks that represent the varied geological history of Fife. Each rock of interest in the wall is described in an accessible way, without the use of too much jargon. The descriptions introduce the reader to the idea that Fife has experienced many different environments, including tropical swamps,

erupting volcanoes, deserts, and ice sheets. The importance of geology to the local history and the shaping of the cultural landscape is brought in through examples such as historical records of the use of Fife lime in the 17th century, and 12th century monks digging for Fife coal. Although this leaflet is very useful for describing the wall, it misses an opportunity to introduce the geological history of Fife as a story. The different rocks are not placed in any time order, so that we jump from mid-Carboniferous to early Permian to Devonian and back to Carboniferous again. This makes it difficult for the reader to

understand how and why all these environments are recorded in Fife's geology. However, Fife Council is producing more in this series of leaflets, and hopefully some will bring out the history further. Overall, though, this particular leaflet is a useful guide to the geological wall, which it is hoped will inspire visitors and local people alike to find out more about the geology of Fife.

– Kathryn Goodenough,
British Geological Survey



Earth Heritage magazine is published twice a year to promote interest in geological and landscape conservation.



The rise of Scotland's Knockan Crag as a centre for visitors.
See page 5.

Photo by
Lorne Gill/Scottish Natural Heritage

