Geodiversity: what it means and what we should do about it

- Balancing Earth heritage and archaeological conservation needs
- Earth Alert: where can we go from here?
- Beach beauty contest
Geodiversity and why we need it

Earth Heritage is a twice-yearly journal produced for the geological and landscape conservation community by the Joint Nature Conservation Committee, English Nature, Scottish Natural Heritage, Countryside Council for Wales, and the Countrywide Council for Wales. The Royal Society for Nature Conservation and the UKRIGS Geoconservation Association are principal contributing partners. We would like to thank all those who have assisted with the preparation of the above organisations.

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A public inquiry into proposals affecting a key Earth Heritage SSSI (Site of Special Scientific Interest) ran last month (July) in Affrinston, East Sussex.

Proposals to build rock revetments at Birling Gap (above), part of the Seafront at Beachy Head SSSI, to try to prolong the life of some cliff-top dwellings, were due to be considered by a planning inspector during an inquiry expected to last the best part of two weeks. The SSSI is notified for its geology, geomorphology and biology, with Birling Gap itself being a GCR (Geological Conservation Review) site because of its Quaternary features and coastal geomorphology.

Erosion of chalk cliffs at Birling Gap creates a key site for periglacial geomorphology and the study of chalk landscape evolution. It is the best example of a complete cross-section through a dry valley anywhere in Britain. The valley is well exposed, allowing access to the deeply weathered and contorted valley floor and the overlying sequence of solifluction deposits. The longer scheme was turned down by the local planning authority, but it was minded to approve the second, smaller scheme.

English Nature argued at the public inquiry that both schemes should be rejected due to their impact on the geological and geomorphological features. The concealment of the dry-valley and disruption to natural coastal processes are particular concerns.

The National Trust, the Countryside Agency and the Sussex Downs Conservation Board share similar concerns on what is a spectacular and unprotected stretch of coastline.

Colin Prosser
English Nature

Hot news from the Ice Age

Seeds, leaves, pollen, bits of insects and the bones of small fish and mammals which thrived in an extended heatwave during Britain’s Ice Age and which were washed into the River Thames over 300,000 years ago, have been unearthed.

The finds were made in Hackney, east London, by archaeologists from English Heritage and scientists from the University of London’s Geography Department.

The number and range of finds from this period confirms that the Ice Age in Britain was the coldest phases when temperatures rose dramatically. Early analysis shows that over 250,000 years ago, for about 20,000 years, southern Britain was as warm as parts of Spain or Italy are today and the area around the Thames was lush with plant and animal life.

Gap in the balance

The inquiry over Birling Gap centres on the fact that some dwellings are threatened by coastal erosion. Some residents strongly support the case for a revetment at the foot of the cliffs which they hope will slow erosion and prolong the lifetime of the dwellings.

Two separate applications for coastal protection using rock revetments have been put forward. One scheme extends for approximately 180 - 220 m, the other for about 30 m. The longer scheme was turned down by the local planning authority, but it was minded to approve the second, smaller scheme.

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The National Trust, the Countryside Agency and the Sussex Downs Conservation Board share similar concerns on what is a spectacular and unprotected stretch of coastline.

Colin Prosser
English Nature

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Warwickshire’s Jurassic legacy

Amidst its diverse geology, Warwickshire boasts a broad strip of Lower Lias (early Jurassic) rocks running through its southern part. The stratigraphic sequence of sedimentary rock-types is well established and compares closely with the classic coastal successions of West Dorset and North Somerset.

In the last century, fine-grained Lower Lias limestones were quarried by hand for flagstones, gravestones, walling and in the manufacture of cement. Many spectacular fossils were found, particularly in the Stratford-upon-Avon district.

These ranged from insects, crustaceans and land plants, to near-complete ichthyosaurs and plesiosaurs.

Sadly, the pits have largely disappeared, although representative sections are protected as SSIs and RIGS. Lower Lias clays and limestones are still extracted for cement as large-scale quarry products.

The days of intact reptile skeletons are largely a thing of the past, but interesting fossils still turn up from time to time.

Warwickshire Museum holds extensive collections of fossils from the quarries of the 19th Century, providing a unique record of the Jurassic environments. These were built up by the Warwickshire Natural History and Archaeological Society. Most of the fossils in this museum are in extremely good condition, the preservation of marine reptiles, in particular, rivaling anything from the Dorset coast. This valuable resource is kept in a closely monitored storage environment to enable its long-term survival.

The Museum also holds a growing number of rock and fossil specimens from the existing cement pits, helping to complete the picture. Close contacts are kept with local councillors and members of the Warwickshire Geological Conservation Group to maintain records.

Temporary exposures of Lower Jurassic rocks are created quite frequently in new house developments and along new roads. Records of these are maintained at Warwickshire’s Geology Locality Record Centre, also located at the County Museum.

Researchers wishing to use these resources or obtain more details of local site conservation schemes should contact me on 01926 424841. The geology gallery includes displays of local Jurassic fossils, including a spectacular plesiosaur skeleton from Witcombe Quarry SSIS, near Stratford-upon-Avon. Entrance to the museum is free.

Jon Radley
Keeper of Geology, Warwickshire Museum
Outcrops

Sites Review

The recommendations of the Local Sites Review Group went to Ministers in April and their considerations have been closely linked to the passage of the Countryside and Rights of Way Bill in Parliament. Members of Parliament debated at Standing Committee and at Report stage with vigorous support, and an Adjournment debate was secured by Geraint Davies MP in the Commons on 12 June. The Bill is, at the time of writing, in the Lords.

Ministers have a firm commitment to take forward work on Local Sites and the Review Group will be reconvened to do this. The Local Government Bill, also passing through Parliament, imposes a duty on Local Authorities to produce sustainable community strategies to promote the environmental, economic and social health of their areas. Statutory guidance on the preparation of the strategies will emphasise the importance of Local Sites within Biodiversity Action Planning.

This is a significant step forward for Geoscience, but the hard work is still to come, ensuring that Earth science remains firmly at the heart of Local Sites work. Partnership and unity will secure the future for Geodiversity, but groups need to be part of the Biodiversity Action Planning process.

Planning breakthrough

By the time you read this, the Peterborough Geology Audit will have formed the basis of Supplementary Planning Guidance (SPG) for Peterborough City Council. As such, it will be the first time that RIGS (Regionally Important Geological/geomorphological Sites) have been adopted so comprehensively as part of the planning process. This is a major achievement, but it has taken two years to get this far and with little on the ground to show for the endeavour.

Peterborough Environment Trust has produced a document called Upon this Rock: the Peterborough Geology Audit*, which is a comprehensive and thoughtfully illustrated guide to the geology of the city, a valuable resource for anyone interested in the area. The book also deals with maintaining and promoting RIGS and implementing the Peterborough Geology Audit — within the local planning and statutory frameworks — and monitoring its success. Each site audited contains sections on the methods used to establish the audit, threats to sites and methods of site selection. The core of the document lists the RIGS, further Important Geological/geomorphological Sites and summarises the geology in a narrative style. The book also discusses the implications of the geology of Peterborough within the context of the city's development.

New parliamentary group

An All-Party Parliamentary Group for Earth Sciences has been established with 20 Members who have included disasters, land use, energy, minerals, water and waste and it will draw on the experience of representatives from all sections of Earth Science. The Group is chaired by Professor Allan Rogers MP and its Vice-Chair is the Rt Hon Clive Shillington MP (North Somerset) and Jane Griffiths MP (Reading East).

New parliamentary group

Project progresses

Work is well under way on an exciting new visitor facility in north-west Scotland focusing on Earth heritage (first reported in Issue 19).

Replacing an older interpretative infrastructure, the Knockan Crag project seeks to brighten public awareness, appreciation of the landscape around Assynt and Coigach, through new access and interactive interpretation.

Knockan Crag, between Ullapool and Lochinver, is one of the UK's top Earth science sites. It is recognised worldwide as the place where a basic principle of geology — older rocks can be driven over younger rocks — was discovered. Yielding a spectacular exposure of the Moines Thrust, the implications of the geology of Knockan Crag sparked controversy when first proposed in the 1860s.

Visitor surveys consistently indicate that most visitors are attracted by the dramatic scenery, but they have little notion of the real story behind the image. Knockan offers the chance to interpret this scenery in new ways and reveal its hidden significance.

The £680,000 development at Knockan is due to open in spring 2001 and will include:

• a new outdoor interpretation and orientation point in the form of a circular stone enclosure, through which the trail will run, plus a hilltop target point, from which scientists and visitors can enjoy the views;
• upgrading of the existing trail and provision of on-route interpretation (including sculptural elements). A second, shorter and easier trail;
• improved access, with extended car parking and an all-abilities pathway, running to the main interpretation point;
• a new area trail linking satellite sites that are important for their landscape interest. At each location there will be signage, parking and fixed interpretation.

Partners in the project are the Heritage Lottery Fund, Highlands and Islands Objective 1 programme, Ross & Cromarty Enterprise, Caithness & Sutherland Enterprise and Scottish Natural Heritage.

John Walters
Scottish Natural Heritage

Earth Alert 2000:

Day one proper of this festival of geology, masterminded by Dick Moody and embraced by the vitreousness of the Earth science community, dawned dry and sunny, but cool. Inside the Brighton Centre it was warming up, ready for the festival. For far too long geologists have been introverted and inward looking, and the new millennium is witnessing a renaissance in raising awareness of the pivotal role Earth Science plays in shaping the future. The festival started with Baroness Young of Old Scone, Chairman of English Nature, delivering a rousing and inspired opening address — quite a feat for someone with little knowledge of geology under two years ago.

The public side stood bunched in the ground floor Mineral and Fossil Fair. But it was quiet elsewhere, with a trickle of visitors into the main exhibition hall and the slightly-off-the-beaten-track Hall A. This hall held The Discovery Room with Rockwatch, Dinosaur exhibits fascinate children (above and left) and a general view of Earth Alert (below). (Photos by Stewart Campbell/Coastal and Marine Unit for Wales)

Dinosaur exhibits fascinate children (above and left), and a general view of Earth Alert (below).
Quaternary geology and archaeology share an important relationship which can be developed and strengthened through joint working and combining resources. There is a huge variety of sites of both geological and archaeological importance. These include fluvial and shoreline sequences exposed by quarrying and deposits laid down within, or washed into, cave systems.

Quaternary sequences often contain palaeo-environmental information that helps to determine how the material was laid down and to establish the prevailing environmental and climatic conditions of the time. Equally importantly, these geological sequences also provide evidence of human activity and occupation – the archaeological evidence which furthers knowledge of the relationship between early man and the changing environment and landscape during the Ice Age.

Two considerations

English Nature makes two considerations when significant geological and archaeological deposits are found on the same site. The first involves the opportunity for combined study and the second looks at the potentially different long-term management requirements for the interests.

Quaternary sites in Essex, Sussex and Kent have long been the focus of combined geological and archaeological research, particularly along the course of the ancient Thames and its tributaries. Purfleet Chalk Pits Site of Special Scientific Interest (SSSI) is designated for terrace deposits overlying the chalk bedrock. The deposits are extremely variable, ranging from cold-stage Corbets Tey Lower Gravel, through the temperate Purfleet Silts and Sands, capped by the Corbets Tey Upper Gravel.

The site is considered to be archaeologically unique in Europe for its lithic content. Suggestions that the site contains worked flints belonging to the Clactonian, Achleuval and Levallois industries are supported by geological correlations with other sites in the Thames basin.

When an access route was to be constructed across the SSSI (as permitted under a previous planning consent), the developer, English Nature and Essex Field Archaeological Unit formed forces to ensure that the sequence was fully recorded and protected where possible.

Initially there were concerns about the amount of extraction that would be needed from a key part of the sequence to build the road. The scheme involved a deep cut and a wide embankment splay. The extraction would have compromised detailed geological and archaeological recording and would have involved losing a considerable portion of the Purfleet Silts and Sands. A second scheme was negotiated, involving a shallower cut and less material extraction. The extraction would compromise the site and its protection.

Once the design was agreed, a team including archaeologists, geologists and biostratigraphers launched a detailed site investigation. Face recording and detailed sampling were undertaken at every stage of development. A detailed site report is being prepared.

The success of this project arose from the common goal shared by the geologists and archaeologists, who worked together to maximise the geological, archaeological and environmental information recorded from the site.

Whilst it is not the first time that sites have been investigated in this way, it is an example of good practice. The team has since worked on other projects, including the site investigation for the A13 road improvement, also in Essex. Here, excavations revealed rarely seen sections through Thames terrace deposits associated with the famous Aveley Elephants, unearthed during the 1960s.

Prevent degradation

Successful long-term management of sites with geological and archaeological interests involves a great deal of goodwill and co-operation.

At Eartham Pit, Boxgrove, West Sussex, the site has been investigated in this way. Once the design was agreed, a team involving archaeologists, geologists and biostratigraphers launched a detailed site investigation. Face recording and detailed sampling were undertaken at every stage of development. A detailed report is being prepared.

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Welcome comments

It is hoped that later this year, detailed planning of the new section can begin, accommodating landowner, developer, geological and archaeological concerns.

Whilst this is not an ideal solution, as the originally described and recorded geological sections will not be available for study, a new and permanent geological section is the most practical outcome for all concerned.

English Heritage recognises that the site at Boxgrove is particularly complex, but would welcome hearing from others who have been confronted with, and worked through, similar challenges. Write to Jonathan Larwood at English Nature, Northminster, House, Peterborough PE1 1UA.

The importance of working in partnership on sites of this kind is clear. Geological and archaeological disciplines have much to contribute to each other and the exclusion of one at the expense of the other detracts from the overall scientific value of sites. Reaching a mutually acceptable solution is not always easy. It can require a great deal of thought and lateral thinking from all concerned.

Further reading

Palaesolithic Archaeology - a geological overview. A. Lavanon, Earth Heritage 4, July 1995 pp 3-5


The Quaternary Research Association can be reached through www.qra.org.uk (see page 10)

Combined survey work being undertaken on the A13 road improvement scheme. (Photo by Natalie Bennett/English Nature)
The Quaternary geological era, approximately the last two million years, has been a time of exceptional environmental change. In Britain, conditions have changed repeatedly and sometimes very rapidly.

During glacial episodes ice has spread into lowland England, reaching the northern suburbs of London, and the sea level has fallen 100 m below that of today. In some of the interglacial episodes the climate has been warmer than today, with southern European species flourishing in Britain, and during the last interglacial, hippopotamuses basked in English rivers. Environmental change continues, perhaps intensified by human interactions with the environment. The threat of global warming and rising sea level is now a significant element in the long-term planning of environmental management.

The Quaternary Research Association is the principal focus of research expertise in the UK in this increasingly important area of policy and planning concerns. It provides opportunities for discussion within the Quaternary research community and is the official UK correspondent for INQUA, the international Quaternary research association. QRA has close links with the Geological Society of London through the Joint Association for Quaternary Research. QRA members have been widely involved in compiling the recently published Geological Society Special Report No. 23, A Revised Correlation of Quaternary Deposits in the British Isles.

Field meetings essential

The QRA, now with a membership of around 1,000 (and growing), originated as the Quaternary Field Study Group in 1964, becoming the Quaternary Research Association in 1968. At the heart of QRA activity has always been the examination of field evidence for Quaternary environmental change. Field meetings are the essential framework of the QRA annual programme. The field guides prepared for these meetings (over 20 currently in print) represent a major contribution to the understanding of the Quaternary of the British Isles and neighbouring areas. QRA also publishes a newsletter, technical guides and a monograph series, Quaternary Proceedings, and in 1986 established the Journal of Quaternary Science, which continues to sponsor.

Interest in the record of Quaternary environmental change has raised concern for effective conservation of the field evidence, an issue that has attracted increased attention recently as part of a more general concern for Britain's natural heritage. The Quaternary record is particularly vulnerable. It consists mainly of weakly consolidated sediments that are inherently difficult to conserve. In addition, many coastal sites have been lost due to coastal protection works, and many inland sites - small quarries and pits - closed during recent years.

Quaternary volumes

The QRA was among the sponsors of the Crewe conference in 1992 - Conserving Our Landscape: evolving landforms and ice-age heritage. QRA members were contributors to the Malvern International Conference on Geological and Landscape Conservation in 1993. QRA is largely responsible, under the direction of the Joint Nature Conservation Committee, for preparing the Quaternary volumes of the Geological Conservation Review, and selecting GCR sites. It is regularly invited by the national conservation agencies to comment on conservation issues with a Quaternary interest. QRA members often provide agencies with information and advice about the scientific and educational significance of Quaternary sites. The QRA has a proactive policy towards conservation, and is exploring practical conservation techniques and opportunities to develop interpretative and educational initiatives in important Quaternary localities.

For further information contact the Secretary, Dr Colin Whiteman, School of Geography, University of Brighton, Cockcroft Building, Lewes Road, Brighton, BN2 4GJ. e-mail: c.whiteman@brighton.ac.uk. QRA home page: www.qra.org.uk/index.htm.

Beaches

If a poll were taken to establish the most beautiful beach in Scotland, which one do you think might win? You may be surprised at the answer.

Scottish Geology Week is a biennial event that seeks to promote interest in the Earth sciences and, in particular, Scotland's unique heritage of rocks, fossils, soils and landforms. As part of last year's event, a competition was established on the Scottish Natural Heritage Web site inviting visitors to vote for the beach they considered to be the most beautiful in the country. The competition's primary purpose was to draw attention to the quite spectacular beauty of Scotland's coastline and the fundamental contribution which rocks, landforms and geomorphological processes make to this.

While entrants could nominate any beach, 12 candidate sites in particular were suggested in order to highlight geology and geomorphological processes at work. Entrants were asked to select in order of preference their personal choice of beach, participants were also able to vote by ballot box.

Encouragingly, the competition generated huge interest - in Angus, anyway! Elsewhere the response was rather more restrained. Accordingly, the winner by a landslide was Lunan Bay (in Angus) with 36% of the vote, local support proving crucial to the beach's success. Runners-up were Kilaran Bay on Colonsay (11%) and Scarista beach on Harris (11%).

It is hoped to re-stage the competition in the future. Now the Web page has been designed, incorporating alternative sites and images will be simple. Therefore there is no coffee-table book to promote the other 640 beaches in Scotland. All that is needed is someone to go and take the photos. Any volunteers?

A full list of beaches and brief descriptions appear overleaf, together with pictures. Sheila Beattie, who runs the Scottish Natural Heritage Web site, and Lorne Gill and Tracey Justice of SNH Publications, were invaluable in helping with the competition by providing and distributing photographs.

George Lees
Scottish Natural Heritage

Image: The 'Singh Sand' of the Bay of Lagg, on Islay. (Photo by Lorne Gill/Scottish Natural Heritage)
Beaches

Scotland's most striking beaches, clockwise from top left

1 Scarista, Harris
Two miles of wonderful deserted beach in the south-west corner of Harris. Like many beaches in the Western Isles the sand here is made mostly of shell fragments.

2 Sands of Forvie, Aberdeenshire
Unlike almost all other dunes in Scotland, which are clothed in marram grass, those at Forvie are bare. Consequently the dunes are mobile and great waves of sand gradually drift across the land from the shores of the Ythan Estuary. It is Scotland's own miniaturised desert.

3 St Ninian's Tombolo, Shetland
Two beaches in one, St Ninian's Tombolo is a sand bar linking Shetland's largest island with the now uninhabited St Ninian's Isle. It is the largest unconsolidated feature of this kind in the United Kingdom. Following storms in 1993 which sank the Bowes oil tanker, it disappeared for a month only to reform again naturally.

4 Cambusdarach and the Sands of Morar, Highland
Immortalised in the film Local Hero, Cambusdarach is one of several small secluded beaches which make up the Silver Sands of Morar, on the road to Mallaig. The ancient volcanic rocks of Rum provide a spectacular backdrop.

5 Kiloran Bay, Colonsay
The natural amphitheatre of Kiloran Bay sits within an area of softer rocks on the Colonsay coastline. These have been eroded more rapidly than the surrounding older and harder rocks to form the shallow sea loch in which this magnificent beach has accumulated.

6 Corran Seilebost and Luskentyre, Harris
This spectacular coastal panorama hits drivers travelling south from the ferry terminal at Tarbert. The spit and dunes shift form continuously as they respond to weather and sea-level variations.

7 Lunan Bay, Angus
A great sweep of beach and dunes stretching for over two miles along the Angus coastline, broken only by the Lunan Water and occasional blowouts through the dune ridge.

8 Sanna Bay, Ardnamurchan
One of many breathtaking beaches around the Ardnamurchan peninsula. These bays sit on the flanks of an ancient volcanic area which was active around 60 million years ago. Remnants of its volcanic rocks form the reefs and skerries which add relief and contrast to the sweep of white shell sand.

9 Salthy Bay, Sutherland
This stunning beach, on Scotland's northern coastline, is well protected from the prevailing westerly winds by the headland of Salthy Point. As a result wave erosion of the dune front is relatively rare, resulting in the regular growth of 'embryo' dunes over the top of the beach.

10 Traigh Lingaigh, North Uist
Traigh Lingaigh is one of a score of equally stunning beaches stretching for 10 miles between the islands of Berneray and Valtay, off the west coast of North Uist. The white sand is due to shell fragments. Above high-tide level the sand forms an especially rich soil - the machair - which in late spring is ablaze with colour of different flower blooms.

11 West Sands, St Andrews, Fife
Another Scottish beach to feature on the wide screen, this time in the opening to Chariots of Fire. The West Sands line the eastern flank of a land spit which has grown over the last 5-6,000 years. With the dunes behind, they protect the world's most famous golf course.

On the preceding page: Bay of Laig, Eigg
Also known as the 'Singing Sands' of Eigg, the sand on the beach here actually squeaks when walked upon! This is thought to be due to the unusual character of the sand grains, most of which are exceptionally well rounded and similar in size.
SSSIs by the thousand...

Raymond Roberts
Earth Science Officer, CCW

Wales' highest waterfall, Pistyll Rhaeadr, has become the country's 1,000th Site of Special Scientific Interest, and was notified for its fluvial geomorphology.

The waterfall, on the southern slopes of the Berwyn Mountains, falls 75 m (240 feet) over an eroded-resistant cap-rock of volcanic ash, and has cut a spectacular natural arch and several plunge pools into the rock. Pistyll Rhaeadr is regarded as one of the 'Seven Wonders of Wales'. However, the site's importance lies not only in the waterfall and related features, but also in the contrasting geomorphology upstream and downstream of the falls. Upstream, the river, known as Afon Digynfa, is an upland, boulder-lined channel originating in peat, and follows a steep, straight course as it runs off the Berwyns - a typical mountain torrent. Downstream of the falls the river changes its name and its character. Here, Afon Rhaeadr meanders across the flat, glacially over-deepened valley floor and demonstrates more lateral activity and depositional features such as point bars and composite banks.

Part of the site, which lies upstream of the waterfall, lies within the Berwyn SSSI which is important for its upland vegetation and bird populations. Because of its geomorphological importance, the new Pistyll Rhaeadr SSSI overlaps part of the Berwyn SSSI.

The primary conservation aims for Pistyll Rhaeadr are to maintain the natural river processes and associated landforms. Close liaison and co-operation between CCW, the landowners and interested parties such as the Environment Agency and any work will allow for the scientific and aesthetic: composite banks.

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The primary conservation aims for Pistyll Rhaeadr are to maintain the natural river processes and associated landforms. Close liaison and co-operation between CCW, the landowners and interested parties such as the Environment Agency will ensure that any proposed development will be carefully assessed and any work will allow for the scientific and aesthetic importance of the SSSI.

To commemorate the SSSI notification, CCW Chairman, John Lloyd Jones, unveiled a plaque and the geomorphological importance of Pistyll Rhaeadr was explained by CCW Vice-chairman, Professor D.Q. Bowen, Professor of Quaternary Geology at Cardiff University.

Pistyll Rhaeadr has allowed a greater understanding of river processes and is important for the future study and understanding of fluvial geomorphology in Wales. The waterfall and its surroundings also attract thousands of visitors each year and provide a great opportunity to interpret fluvial processes to the public.

The spectacular Pistyll Rhaeadr waterfall (main picture) with the upstream section (top inset) and the Afon Rhewlad valley downstream (left). The plaque unveiling (above) by John Lloyd Jones. (Photos by Stewart Campbell/Countryside Council for Wales)
Perhaps it will eventually also outlaw the sale of peat-based compost; merely restricting extraction does nothing to maintain that element of goodvossity. Further up the country are the towering chalk cliffs at Bempton, near Bridlington. They are home to England’s only ganet colony and the country’s largest marine bird site.

**Universal solvent**

Water, the universal solvent, carves a bed across every rock type and, in some, it is quite spectacular. Take High Force in Upper Teesdale where the peaty Tees plunges 25 m over the Whin Sill that also holds up much of Hadrian’s Wall. That rock, a dominant feature in Northern England, is greatly utilised for prominent buildings, almost entirely for fortifications such as the castles at Bamborough and Alnwick, and it also produces the nesting sites and seal swims of the Farne Islands. Water has also created the wonderful incised meander of the Wear at Durham producing the setting for the architectural World Heritage Site comprising Durham Castle and Cathedral.

Less spectacular, but nonetheless special, is the Upper Tees at Killhope, where the water was used to wash the lead ore from its gangue minerals.

**Best example**

Landscape and the rocks that make it figure greatly in the remains left by the Romans. Hadrian’s Wall is the best example and easily seen in southern Northumberland, where it sits on the Whin Sill. A wall on top of a sheer cliff of dolerite makes an unscalable defence! The Isle of Bute, a mixture of igneous and sedimentary rocks, has breathtaking views of Arran from the almost white sands of SapliscBay beach, where inquisitive seals swim close and the south-western end of the Highland Boundary Fault can across the island on its way to mainland Scotland. White sands, the result of active processes on the quartz-rich rocks, feature in the west of Scotland and the Outer Hebrides. Another feature of the west is the deep, peat-dark sea loch – places where fish farms abound and tourists tarry. John O’Groats is disappointing in landscape terms, but its local Caithness Flags provide the unique stone walls, ultra thin yet fulfilling the need to demarcate property and confine stock.

Igneous rocks and castles seem suited to each other. Think of Edinburgh Castle and the volcanic plug on which it sits. Bamborough or Stirling draw countless visitors who probably never think why the castles are there or what they are built from. Architectural historians may reveal that a building is of stone but rarely whether it is igneous, metamorphic or sedimentary. The Isle of Bute, a mixture of igneous and sedimentary rocks, has breathtaking views of Arran from the almost white sands of SapliscBay beach, where inquisitive seals swim close and the south-western end of the Highland Boundary Fault can across the island on its way to mainland Scotland. White sands, the result of active processes on the quartz-rich rocks, feature in the west of Scotland and the Outer Hebrides. Another feature of the west is the deep, peat-dark sea loch – places where fish farms abound and tourists tarry. John O’Groats is disappointing in landscape terms, but its local Caithness Flags provide the unique stone walls, ultra thin yet fulfilling the need to demarcate property and confine stock.

Very different are the dry-stone walls of the Yorkshire Dales with their through stones for strength and ease of climbing, or the old Roman walls of the Newhaven area of the Peak District with very large base stones. Nineteen different wall types, built from their local rocks, are displayed in the millennium wall at the National Stone Centre at Wirksworth, Derbyshire.

Conversely, limestone is the major source of quicklime, sugar-stone, cement, dimensional stone and aggregate and must be won by quarrying. Sustainability is about striking a balance between demand, extraction and visual impact. Glacialized valleys, cliffs, smoothed rock surfaces, truncated spurs, maraines and erratic are the backdrop of Snowdonia, from where the best slates in the world are quarried. From the end of the 18th Century until the middle of the last, the purple-grey slates were transported far and wide on newly built railways to roof Britain. Local materials that were once supremo now made way for exotics to clad buildings and create new ones.

Triasic sandstones in Carboniferous country, Cornish granites in Midland towns, Scottish ledges in Yorkshire and Lancashire mill towns, and architects willing to experiment and learn with the mix of stone and iron and steel. Telford spanning the Menai Strait with engineering marvels, leaving a lasting legacy here and at Llangollen where the half tube is filled with water to take the canal on the Pontcysyllte high over the Dee.

**Geo reserve for the public?**

Volcanoes again at Cadair Idris, royal gold in Bont Dhu near Dolgellau, colour-washed houses on steep valley sides and small ports on the coast. Farther south, black gold from the valleys and their spoil heaps, all that is left of a proud industry and even those visual reminders have all but disappeared. Can one or two examples of spoil heaps be saved? Can one be found packed full of plant and insect fossils to create a safe geo-reserve for the public to experience the thrill of being the first to see the fossilised remains of a plant over 300,000,000 years old? The ground-breaking rock store managed by the Geologists’ Association at Wirral and the National Nature Reserve can surely be matched by sites in South Wales, Kent and Devon. We need to maintain this access to the heritage of the coal industry. Spoil is the last tangible legacy of that great mining past.

Water, the universal solvent, dissolves and gurgles its way through the Carboniferous limestones of South Wales, dissolving and depositing calcium carbonate, creating the massive caverns and sponges of Dan yr Ogof and its sister caves, loved by potholders and less adventurous visitors.

Limestones figure greatly in the “earth’s and wondrous” Cardiff Castle, built in the late 19th Century. The castle has...
Roman blue Lias limestone remnants, surrounded by pinkish Swindon stone from Culverhouse Cross and the yellowish Creigiau stone from a few miles to the north of Cardiff. The granites of the steps of the National Museum of Wales, across the road from Cardiff Castle in Cathays Park, are Cornish from Bodmin Moor. Steps to the other buildings in this superb suite of municipal structures – the Law Courts, City Hall, University College, the Police Station, the Temple of Peace, the National Assembly and the University of Wales Institute of Science and Technology – are coarse Carboniferous sandstone. Cardiff city centre and Llandaff Cathedral show a microcosm of British and European building and decorative stones: some 108 different types are used.

**Local stone**

This contrasts with Exeter, where most stone used for building was local. Take Exeter’s underground passages, which were originally built to make access easier to the lead pipes supplying water to the properties of the Dean and Chapter of the Cathedral. The original pipes were laid in trenches about 1170, but enlarging the Cathedral in the 1340s gave an opportunity to build a vaulted passageway in purple-grey basalt, locally called trap, from the site of Rougemayr Castle in the city centre. Later, in the 1400s, passages were constructed in a Permian breccia known as Heavitree stone. Exclusive stone quarried two miles east of Exeter.

Finally, no grand tour of British geodiversity is complete without mention of Ireland’s fantastic limestone landscape of The Burren or the visual delights of the Antrim coast. But all is not well............The basalt columns of the Causeway Coast in Northern Ireland, east of Giant’s Causeway, are now unable to be visited due to the collapse of the lower coastal path in 1995 and its closure on safety grounds. They and the Giant’s Causeway itself are the basis for the justification for a World Heritage Site designation. The succession of lava flows and interbasaltic beds, the regular columnar jointing of the Tholeitic basalts, the Causeway, the cliff exposures of columnar and massive basalt, the spectacle they present and “the extent of visible rock sections and the qualities of the exposed columns in the cliffs” were the substance of the submission. The closure of the lower path has arguably removed reasonable access to the main geological interest of the Causeway Coast, except the causeway itself. It puts in risk the continuing presence of Britain’s only completely geological World Heritage Site.

**What can be done**

Will it take removal from the World Heritage list before an elegant engineering solution to the instability problem of the lower coastal path can be put in place? Can Heritage Lottery money help to remedy the lack of action? Shouldn’t we be asking questions in Parliament? Can a flexible structure be built, like the new millennium bridge over the Thames, to provide access to this natural wonder? Can we maintain Britain’s geodiversity and can we increase public enthusiasm for it and people’s access to it? We need to.

**Time to stand united**

from page 7

bring down 25,000 tonnes of Mendip limestone; the BBC’s “Walking with Dinosaurs”, and Tarmac showing a strength of materials test kit – a rather prosaic name for a fun activity comprising arm strength to raise the weight and wonder when the rock would shatter. Free posters from virtually all exhibitors, free pens, pencils, free mugs from the Institute of Petroleum, free humps of coal from RJB Mining, free rock (edible) from Quarry Products Association, free booklets from Hanson, free mouse mats from Texaco, free explanations of processes, principles and preservation from the three conservation agencies, English Nature, Scottish Natural Heritage and Countryside Council for Wales. Visitors could learn about the Dinosaur Isle (Museum of Isle of Wight Geology), the geology of Islington, of Shropshire, William Smith, Mary Anning. see a Jurassic garden, RSNC working next to UKRIS, all surrounding a full-size skeletal model of a stegosaur.

Outside the main exhibition, the refreshment counter housed the student poster competition entries. Two caught my eye, sulphur flows from the OU and an evaluation of global warming from Kingston. Both posters used faded text was too small, with its white background, and contrasted with the OU poster, which had easily readable colour pictures as backgrounds, with a mixture of text, diagrams and photographs. The Kingston piece was the result of a Powerpoint presentation, but did not work as a poster because the text was too small, with its white typeface on blue background. Contrast the OU poster, which had easily readable text, making it very accessible. There must also be special mention for a Chester College student’s poster on the conservation of limestone pavements at Bryn Alyn, in North Wales.

I suspect that 1 in 10, the number of Departments offering posters on conservation, is near the actual ratio of students being taught conservation in British universities. It is perhaps the main reason why there are no students graduating with an understanding of the need and importance of conserving Earth science features.

**Audience spellbound**

Two public lectures on Saturday, given by David Norman and Bob Symes, looked at Dinosaurs and Minerals. Both held their audience spellbound and attracted upwards of 350 people.

Contrast the Festival lectures, also given by the best in their field, but sadly not aimed at the public. This was reminiscent of Geoscience 2000, another festival, but only for professionals and would-be professionals – no possibility of contact with the public, no attempt to inform or engage the public in the importance of the Earth sciences, no open day, no invitation to exhibit collections or be involved with activities – no accessible Earth science!

We need to work much more closely together. There are insufficient geologists to be in competition with each other, and why should we work independently at a much greater cost in both money and resources? Partnership and unity to promote geodiversity needs to be the watchword. Perhaps Geofest 2002 could see the Geologists’ Association working with the Geological Society to produce a festival for the public, for the amateur and for the professional.

Well done Dick Moody for having the vision to promote Earth science in a much more accessible format. Earth Alert is not a title that inspires, but as an event it was successful, not in terms of numbers of paying visitors but in terms of the quality of the experience. 100% top quality for families who were engrossed in activities. Change the name and repack the event about every two years and make it free and Earth science could become an intoxicating to the public as a good wine.
New opportunities for geological enjoyment and research have been created around England, thanks to English Nature's £150,000 Face Lift site enhancement programme.

Face Lift is a practical programme for works on geological and geomorphological Sites of Special Scientific Interest, and one of the first initiatives under English Nature's new strategy for Earth heritage conservation, The Past is the Key to the Future.

Through working with others, we will continue to encourage the innovative and responsible use of Earth heritage SSSIs around England for research, education—and for fun. Promoting Earth heritage can encourage people to value their local SSSIs, which in turn helps to protect them from development or neglect.

Jest over one year in to this two-year scheme, JCBS have turned in to clear exposures in many parts of the country, and innovative management techniques have revealed new features. Now, we would welcome suggestions for more projects, together with news of how geological groups, researchers and others individuals are putting Face Lifted sites to good use.

Over £66,000 has been spent on works to help conserve 45 SSSIs across England since April 1999. Site management signs and boards have also been produced to help groups, researchers and other individuals manage access to a further 75 sites. This success is due in large part to the support given by partners to this initiative. These partners include:

**RIGS and local geological groups**

Local knowledge and enthusiasm is important to the effective conservation and promotion of Earth heritage sites. To date, English Nature has worked with Dorset, Gloucestershire and Hereford and Worcestershire RIGS groups on the enhancement of SSSIs (see page 22).

**Landowners and tenants**

Local Authorities are often keen on Earth heritage, but may need help to make the most of their sites. Through Face Lift, Dartmoor National Park Authority, Swindon Borough Council and North Yorkshire County Council have developed experience in furthering geological conservation.

**Wildlife Trusts and other conservation organisations**

About 1 in 10 of all SSSIs owned or managed by Wildlife Trusts are of national importance for their geological or geomorphological features. Face Lift has helped Wildlife Trusts in Surrey, Leicestershire and Rutland and Oxfordshire to gain experience in conserving and promoting Earth heritage sites.

**The future**

Proposed works on a further 40 SSSIs should be complete by April 2001. We look forward to building on this year's momentum and experience and aim to support and enable more groups and individuals to manage and promote their local Earth heritage SSSIs. We also expect and encourage more use, where possible, to be made of those SSSIs enhanced to date.

Existing geological SSSIs need conserving for future geologists, irrespective of current uses or research trends. However, many sites are regularly used today, and we need to identify which are, or could be, the most popular and useful SSSIs for education and research, so we can target our promotion and enhancement, and help secure more resources for Earth heritage conservation.

While enhancement may help to protect a SSSI, increased access may also increase the risks for some vulnerable features. We will continue to work with geological groups and individuals to promote a culture of responsible use. Suggestions for 'adoptions' by voluntary groups of suitable SSSIs are welcomed.

If you want to talk about any ideas or suggestions that may be suitable for Face Lift, then please contact me via the English Nature Somerset office, Roughmire, Bishops Hull, Taunton, TA1 5AA, tel 01823 283211, e-mail: kate.jeffreys@english-nature.org.uk.

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**Face Lift achieves enhancements**

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The Mortimer Forest Site of Special Scientific Interest is a dispersed set of eight forest track sections on the Herefordshire-Shropshire border which illustrates the full succession (see table) of a pitching anticline, where rocks of the Wigmore Dome. It is a wonderful example of RIGS conservation, sometimes referred to as the Wigmore Dome. It is a wonderful example of RIGS conservation.

Proposals for restoration and vegetation to carry out remedial work and was the local English Nature team and formal programme. It illustrates how the expertise of RIGS groups can help English Nature manage geological and geomorphological SSSIs.

Groups already involved in similar co-operation with English Nature know the benefits: recognition of professional status, streamlined working links, successful track record, better geoconservation and improved finances.

Payment for the Mortimer Forest project has enabled Herefordshire and Worcestershire RIGS Group to continue with its programme of producing geological trail guides and Shropshire RIGS Group plans to produce an itinerary as part of a proposed Geologists’ Association guide for the south Shropshire area.

The renovated sections

Of the eight sections of the Mortimer Forest SSSI that were surveyed, three were deemed to need urgent remedial work. All lie deep in the forest.
Development of the Wairakei field for geysers. The Orakei Korako field was abandoned, and Spa. Only Whakarewarewa remains largely drowned when the Waikato River was raised for hydro-electricity. Orakei Korako, Whakarewarewa, Wairakei, and other geothermal marvels in the 19th Century spa wonders continued to attract attention from domestic and industrial use.

The current situation warrants concern. That many of the spectacular features themselves. The plant life associated with geothermal features is special because it is unique to the harsh geothermal environment and vulnerable to human interference. Few people know of the rare thermal orchids and mistletoe, or that the dark orange coloration commonly seen on geo-thermal vegetation is a fungus. On a national botanical conservation values ranking system, Whakarewarewa's geothermal vegetation rates the highest possible. The vegetation at Silica Flats rates the third highest. Similarly, wildlife habitat values at Silica Flats reach the second highest possible ranking, while at the Motutara Point wildlife refuge and sanctuary, wildlife habitat values are the highest.

The cost should not be measured in terms of scenic attraction, cultural significance, potential for scientific study and energy sources alone. These geothermal landscapes are outstanding natural ecosystems comprising native thermal vegetation, formations and the features themselves.

Restricted use of bores

Recently, local debate was sparked by a case brought to the Environment Court under the Resource Management Act of 1991, the Ministry for the Environment empowers local authorities (regional and local government) to control the effects of human activity on geothermal resources. In the Rotorua area this is Environment Bay of Plenty (regional council) and Rotorua District Council.

Environment Bay Of Plenty has a Rotorua Geothermal Field Regional Plan to meld protection and use of the Rotorua geothermal field. In remit includes the use of bores for energy consumption and protecting notable geothermal features, like Pohutu geyser.

Penny Hurlstone
Community Relations Officer, Public Awareness
Bay of Plenty Conservation Office, New Zealand North Island

Marie Long
Community Relations Officer, Planning
Rotorua Geothermal Field Regional Plan to protect notable geothermal features, like Pohutu geyser.

The current situation warrants concern. Five major geothermal fields existed in New Zealand 110 years ago - Rotorahuna, Okariki Korako, Whakararewa, Wairakei and Spa. Only Whakararewa remains with any significant number of active geysers. The Okariki Korako field was largely drowned when the Waikato River was raised for hydro-electricity. Development of the Wairakei field for geothermal energy resulted in a dramatic decline in groundwater levels at both the Wairakei and Spa (7 km away) fields and the loss of surface features such as all 70 of its geysers and at least another 170 alkaline springs.

The Rotomahana field was destroyed by natural causes - the 1886 Tarawera eruption. Of more than 200 geysers active in the central North Island in the 1950s, just over 40 remained in the 1990s. Whakararewa's Geyser Flat is therefore New Zealand's only remaining major field, yet even a number of its geysers are no longer active. Waiotapu geyser last played in 1968 and its present dormancy is the longest on record. The Waiowae geyser, which used to play to heights of up to 60 m, last naturally erupted in 1940 (it played through the 1950s with the aid of soap). The geyser terraces featured a series of pools as recently as the 1970s but these have now been overcome by invasive grass.

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Plant life is special

The plant life associated with geothermal features is special because it is unique to the harsh geothermal environment and vulnerable to human interference. Few people know of the rare thermal orchids and mistletoe, or that the dark orange coloration commonly seen on geo-thermal vegetation is a fungus. On a national botanical conservation values ranking system, Whakararewa's geothermal vegetation rates the highest possible. The vegetation at Silica Flats rates the third highest. Similarly, wildlife habitat values at Silica Flats reach the second highest possible ranking, while at the Motutara Point wildlife refuge and sanctuary, wildlife habitat values are the highest.

At the Motutara Point refuge, the warmth of the water and environmental conditions create a 'hot spa'. The adjoining Sulphur Point Wildlife Sanctuary is an outstanding habitat for waterbirds. The threatened New Zealand dabchick, banded dotterel, scaup, shags, pied stilts and Caspian terns are just some of the area's residents. Small silica inlets within Sulphur Bay provide a nationally significant site in one of few North Island colonies of black-billed gulls.

A number of measures is already in place to secure the future of the area. The Department of Conservation manages a number of sites for conservation purposes through the Conservation Act or Reserves Act. Many of these are used for recreation and tourism. While these features can be protected on such lands, the energy source for the fields is often found beyond the boundaries of the protected areas.

Through the Resource Management Act 1991, the Ministry for the Environment empowers local authorities (regional and local government) to control the effects of human activity on geothermal resources. In the Rotorua area this is Environment Bay of Plenty (regional council) and Rotorua District Council.

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Restricted use of bores
Belfast stone


This attractively designed, colour-illustrated guidebook provides a good introduction to the diverse range of building stones of Belfast. It generally achieves the objective to provide both locals and visitors with an appreciation of principal rock types and how they are used. It is written in a relaxed style and has potential for school use. Whilst there is much of interest to non-geological professionals (e.g. architects) there is scope for a more technical volume.

The introduction to rocks, minerals and stone scales (Section 1) is succinct. However, the illustrations in this section are poor. Plates 2 and 3 (examples of sedimentary, igneous and metamorphic rocks) fail to do the materials justice and are of little assistance to the reader. Although Figures 3 and 5 adequately demonstrate diagrammatically sedimentary and metamorphic layering, this could be achieved more effectively using photography.

In Section 2 - on the building stones - we learn that granites came from the Mourne Mountains, Pentland and Eastlothian. Gabbros have been imported from South Africa and from Ballachulish (presumably ‘Kentaiite’?). Mention of Ballachulish recalls the UK slate industry. Although little is said about slate, this most useful of metamorphic rocks, at the leasgation of St Peter’s Church (C.O.I) will be pleased to learn what keeps the rain out. Marlstones and their decorative use get a fair mention. Of the sedimentary rocks, Portland Stone features, as do the local Scirapo and Dunagunn sandstones. Scottish and Welsh sources are highlighted. It is good to see descriptions of weathering properties. The importance of these characteristics cannot be overstated to architects and builders. Locally manufactured and imported bricks are also described.

Sections 3 to 5 guide the reader around the main commercial buildings and churches (with dates and materials). Local geology is succinct. However, the illustrations in this section are poor. Plates 2 and 3 (examples of sedimentary, igneous and metamorphic rocks) fail to do the materials justice and are of little assistance to the reader. Although Figures 3 and 5 adequately demonstrate diagrammatically sedimentary and metamorphic layering, this could be achieved more effectively using photography.

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

Sweeping patterns at Ring undertow, near Llanelly - a striking example of the UK's rich variety of geological treasures.

On page 13, Nick Stanley looks at the country's geodiversity and considers how to conserve it and improve people's understanding of it.

(Photo by Stewart Campbell)