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The Geologists' Association
The Association, founded in 1858, exists to foster the progress and diffusion of the science of geology, and to encourage research and the development of new methods. It holds meetings for the reading of papers and the delivery of lectures, organises museum demonstrations, publishes Proceedings and Guides, and conducts field meetings.
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Please note that the dates given are for the Circular. They also represent dates at which the magazine will go to press. However, because of the greater time required to set the magazine, items should be submitted as soon as possible and not targeted on these dates. We welcome contributions from Members and others. We are currently limited to 24 pages. Pictures for publication can be as slides, photographs or high resolution digital images - preferably on CD.

Advertising Rates
Full Page £360 Half Page £190
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Cover picture 'The largest known standing trunk of a petrified tree in Europe in the fossil forest of Lesbos. An ancestor of the Sequoia, this one is 7.02 metres high and 8.58 metres circumference. The start of the root system is just visible at the base. Scale provided by David & Jessica Bone.' See page 17.
Photographs - David Bone

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NOTICE CONCERNING FIELD MEETINGS:
The Association now has a mobile phone for emergency communications concerning field meetings (UK only). If you have to cancel on the day, or are lost or late for the start of a field meeting, please call the GA mobile phone (07990 806961). The mobile phone will only be switched on just before and during field meetings.
(For routine enquiries, please call the Field Meetings Secretary on the usual number.)
The Association

from the Treasurer

Subscription increases: Many Members will be justifiably concerned about the increases in subscriptions that took place both in 2003 and are proposed for 2004 and may not understand the justification for such increases, the following outlines the reasons.

1. Interest rates are now at a 40 year low and subscriptions are earning only 2.5% interest in our working bank account compared with over 6% in the mid-nineties. The Association’s investments then provided much more annual income from subscriptions.

2. As a charity the tax paid on our equity dividends used to be reclaimable, but the reclaim is progressively being removed by 4% each year and will disappear altogether shortly. This has already significantly reduced our income and will reduce it further.

3. Almost all our costs continue to increase. Employer’s Liability Insurance, which is a compulsory levy, has almost doubled in the last three years; postage has increased, particularly for the range in which many of the publications members receive fully; the employer’s and employee’s National Insurance levy increased by 1% in April 2003; and salaries increased in the London area by about 3.5% during this last year.

4. At the same time our membership is very slowly declining so that the fixed costs fall on a smaller number. [Recruit more members!]

Nevertheless it should be understood that even with the larger membership of e.g. 2240 in 1997, compared with 1950 in 2002, the Association was chronically in deficit in that expenditure exceeded income and had done for some years. To some extent this was hidden by the unrealised gains which the Stock Market provided in the nineties, which went into reverse after 1999.

5. Bequests and donations have made an enormous difference but their receipt is erratic and in the last few years fewer sums have been received. We have to budget to at least break even without them. Nevertheless as such bequests are tax-free, please consider whether you can reduce the estate duty payable on your estate by making a bequest to the GA.

Of course we have made economies both in salaries and in general expenditure, but the above are the basic reasons why subscriptions need to increase in 2004.

Bernard Leake
Treasurer

Curry Fund Report

The Curry Fund met in June and had four new grant applications to consider and two deferred ones. Of those deferred from the March meeting, the application for support for analysis of a small reptilian coprolite was refused. The application from the British Institute for Geological Conservation (BIGC) was supported with a grant of £2000. This is towards the cost of information boards for the Cape Horob Quarry, an SSSI which BIGC has recently purchased with funds from the Welsh Sustainability Fund and help from the Countryside Council for Wales.

Of the new applications, one, for funding to support PhD student travel was refused. BGS was agreed to support a videoconference for schoolchildren in Chile. The UK part of the project, which originated from a Chilean government institution who will be providing most of the project funds, will be managed by a Chilean PhD student working at the University of Bristol. It is aimed at some 700 primary school children at various sites throughout Chile and will introduce them to the study of palaeontology experiences from Bristol. The long-term aim is to encourage the development of palaeontological studies in Chile. A grant of £2000 was awarded to Durham County Council Cultural Services for the production of 42,000 leaflets to be delivered to all schools in the area. These will highlight a major exhibition and a series of activities throughout the summer on dinosaurs and the area’s geological heritage. Finally, a grant of £600 was awarded to Lancashire RIGS towards the cost of a guide booklet on the Hodder Valley. This is the final part of a much larger project undertaken by this RIGS group on its Lancashire Geological Interpretation project.

Whilst we might have received somewhat fewer applications in June, all of those we supported were aimed at encouraging and educating the public in various aspects of geology and the Cheltenham project does seem especially interesting. The GA is becoming known worldwide for its support of innovative and important geological projects, and I think we can be justly proud of this.

Information for applicants can be downloaded from the GA website or obtained from the GA office at Burlington House. We look forward to hearing from you.

Susan Brown
Curry Fund Secretary

Library Notes

Things are on the move in the library at University College and this may cause some disruption to services for users visiting in person over the summer. Geoscience journals covering geology and physical geography are staying on the third floor. Biological science journals covering biology, zoology, botany and ecology are moving to the first floor where geology books are currently housed, and human geography journals will be shelved just outside the first floor reading room. Finally, the geology books are moving from the first floor up to the third floor. This will bring the books and journals on our subject together into a themed geoscience section of the library where they may be better housed and further from the current noisy building works for other departments which are in progress on the UCL site.

All these moves should take approximately two weeks starting on or around the week beginning 18th August. However, we could expect prior pockets of disruption as material is juggled around. Staff at the DAMS Watson library will do all they can to assist with helping you find known items but I must advise you that browsing will be impossible during this time. The message is really, check before you visit to give staff time to retrieve items for you. Other, more usual, housekeeping has to go on at this time too as older journal issues may be moved to off-site store.

On top of this there are the UCL library summer opening times to be taken on board. During the long vacation the library is open Monday – Friday from 9.30 a.m. – 19.00 p.m. with the issue desk closing at 18.45 p.m., although on Wednesdays this will not open until 10.00 a.m. The library will be closed on Saturdays and Sundays until term starts on 22nd September.

By the way, none of the moves affects the maps for which you can contact me through the office.

Elaine Rimpson
Librarian

Report from Council

This report covers the Council meetings for June and July.

In June the President reported on the attendance at a meeting to consider European Geoparks - see elsewhere in this magazine. Council expressed support for such projects.

The Treasurer reported that the GA has had to absorb increase costs in such things as postage and employers’ liabilities. Tax declaration on dividends is being progressively removed. In view of this and the fact that the GA’s expenditure is more than its income, in spite of drastic reductions in expenditure, is agreed that the subscriptions to the Association should be increased. The GA received over £9,000 from the Inland Revenue as Gift Aid refunds. This is with only about half the membership having signed up to Gift Aid.

All members are encouraged to sign up for Gift Aid. If in doubt contact the office!

Most Council members are expected to have an interest in some aspect of the workings of the GA. Since this was the first Council meeting for some Council members they were allocated to various committees including the newly established Promotions Group formed to increase the GA exposure and increase membership.

The Rules of the Association need to be brought up-to-date to reflect the present structure of the GA and to remove anomalies that have crept in. A committee set up by Council has looked through the rules and presented to Council its recommendations. Council approved these changes so they could then be presented to the Charity Commission.

Council and the Publications Committee have been discussing the problems of copyright which affects all the GA’s publications especially GA Guides which use many maps, all of which must have copyright approval. Even the OS grid references are copyright!

Rockwatch continues to thrive, with many events this year. Council expressed its thanks to all involved with this success. There is always the problem of the continued funding of Rockwatch, and suggestions for sources of funds are needed.

John Crocker
General Secretary

'The Geological Cat Walk: Models & Super Models Exploring the Earth's Crust in 4 Dimensions'

Prof. Stuart D. Burley
1: Exploration and Development Geoscience, BG Group, 100 Thames Valley Park Drive, Reading, RG6 1PT email: stuart.burley@bg-group.com
2: Basin Dynamics Research Group, School of Earth Sciences, University of Keele, Keele, Staffordshire ST5 5BG

3rd October 2003
Geological Society, Burlington House, Piccadilly, W1V 0JU, at 6.00 pm, tea at 5.30

Exploration for hydrocarbons has always been an exciting past-time. Whether mapping desert outcrops, sampling source rocks in far-off exotic lands, or logging drilling mud on an exploration rig in the inhospitable North Sea, the quest for hydrocarbons has had the feel of being at the 'frontier'. For the latter day petroleum geologist that frontier has moved into the virtual realm of the computer, but it's still exciting stuff!

Petroleum geologists reconstruct sub-surface sedimentary basins in 3D, through time – so-called '4D' – with powerful computers to aid exploration, well planning and production strategies. Immersive computer projection technology enables teams of geophysicists, geologists and engineers to wander through their virtual sub-surface space as never before. Basin modelling has become a powerful tool for investigating the whole basin-scale hydrocarbon system, imposing a rigorous, systematic approach to prospect evaluation and provides new insights into the processes of hydrocarbon migration, including flow rates, migration distances and charging histories. 'Super models' of sedimentary basins can be built with hundreds of millions of cells, each populated with geological properties, at a metre scale resolution, and simulated in a few hours. The ability to run multiple simulations of these models, particularly where data are scarce, allows the explorationist to pose 'What if?' questions to investigate the sensitivity of any petroleum system to critical parameters, such as source rock properties. At the reservoir scale, multi-million cell geological models of the reservoir structure, geometry and properties are up-scaled to sophisticated flow simulation models containing 100's of thousands of cells that are used to plan the optimal location of wells and define the production history of the field.

The petroleum geologist of today still needs a 'geological sixth sense', but is now more interdisciplinary in outlook and more computer literate than ever before. It’s still an exciting time to be a petroleum geologist, and reveal more about the nature and behaviour of the Earth's Crust.

Annual Reunion - November 8

The Annual Reunion this year is at University College. It will be held on Saturday 8th November 2003 from 12.30 to 4.30 pm.

We expect to see exhibits from individual GA Members, Local groups and Affiliated Societies, entries into a Photographic Competition, the GA Archives, slide shows, and much more including a Rockwatch Activity Room - for children. Details of the photographic competition are given in the Circular.
TICKETS NEEDED:
We expect this lecture to be very popular - numbers MUST be limited to 180. Tickets will be needed: obtainable from Sarah Stafford at the GA office, at the October meeting, or at the Reunion. Otherwise, please write with a SAE. There will be a book signing before the lecture with the book being sold at a special reduced price.

MICHAEL BENTON
Department of Geology,
University of Bristol
When Life Nearly Died
5th December 2003
Geological Society, Burlington House,
Piccadilly, W1V 0JU, at 6.00 pm, tea at 5.30

Two hundred and fifty-one million years ago, at the end of the Permian period, life was almost completely wiped out by an environmental catastrophe of huge magnitude. Perhaps only 5% of species survived. The extinction of the dinosaurs 65 million years ago was a minor event by comparison.

At the end of the Permian, complex ecosystems on land and in the sea were picked apart and destroyed. Coral reefs, fishes, shellfish, trilobites, plankton, and many other groups in the sea disappeared. On land, the sabre-toothed gorgonopsian reptiles and their rhinoceros-sized prey, the dinocephalians and pareiasaurs, were wiped out. After the event, the Earth was a cold, airless place with only one or two species eking out a poor existence. What happened, and how did life recover?

This catastrophe was first recognized about 1840 - after all, it is marked by an amazing turnover in the fossil record - but scientists have only begun to tackle it seriously in the past ten or twenty years. Why did it take so long to come to terms with the largest environmental crisis ever? The reasons are buried in a major disagreement among geologists in the 1820s and 1830s, the battle between the catastrophists and the uniformitarians. In the end, the uniformitarians effectively won, and their victory has affected the way earth scientists view the world for 150 years. In a slow process, since 1960, geologists have come to accept that much of what the catastrophists of the 1820s had said is in fact true: the Earth has been subject to huge cataclysms in the past - impacts of meteorites small and large, vast and seemingly inerminable volcanic eruptions, huge explosions of carbon dioxide from frozen stores deep in the oceans.

In his new book, When Life Nearly Died (Thames & Hudson, 2003, £16.95), Mike Benton documents exactly what happened 251 million years ago, how the astonishing and complex ecosystems on land and in the sea were substantially reduced, perhaps in as little as a few tens of thousands of years. The killing models are controversial - was it all caused by the impact of a huge meteorite or comet over 10 kilometres in diameter, or by prolonged volcanic eruption in Siberia? The evidence has been accumulating through the 1990s and into the new millennium, and it is weighed and dissected in detail.

The lecture is not a distant journalist’s account of how our understanding of this worst-of-all environmental catastrophes has developed. It is an insider’s view, from the geologist’s field camp in Greenland and Russia, from the laboratory bench, of how a panoply of scientists are pursuing a major interdisciplinary goal. The story involves geologists, palaeontologists, environmental modellers, geochemists, experts on biodiversity and conservation, even astronauts. Their working methods are dissected and explained, and the current disputes are laid bare. The implications of our understanding of crises in the past for the current biodiversity crisis are also presented in detail: here, the past can truly be a guide to the present and the future of life on Earth.

Michael Benton is Professor of Vertebrate Palaeontology and Head of the Department of Earth Sciences at the University of Bristol. He has written 150 scientific articles, and over forty books, many of them standard technical works and textbooks, as well as popular books about dinosaurs and the history of life.

Both pictures are by John Sibbick.
Field Meetings

GEOLOGY OF ESSEX 
CHURCHES – ALL 
SAINTS MESSING 
Visited on a GA Field 
Meeting

Leader – John Potter

Professor John Potter is a leading authority on the constructional materials used over the centuries in the building of churches within the London Basin. In recent years he has led GA parties to the churches of several areas – all in all making a much longer review than can be accommodated in a single issue of the GA magazine. His account for Essex has been rearranged to allow individual churches to be described. This article gives a flavour of his considerable knowledge and expertise with reference to just one of the many Essex churches he has examined — All Saints, Messing, near Kelvedon. Many years ago Alec Clifton-Taylor said that ‘Essex is the best of the Home counties for churches’.

This church is located just off the A12(T) and best accessed via the B 1023 at Kelvedon and can be said to be currently relevant in that President George Bush’s ancestor, Reynold Bush, emigrated to America from the village in 1631. It has been suggested that Messing, originally spelt Mething (the place of slaughter) was the locality where the Romans finally defeated Queen Boudica.

The earliest dated portion of the church is 13th century (from the blocked narrow-pointed lancet window in the south chancel wall, just visible in Figure 1), although records show that a parish priest was in office in 1194. The church has been much rebuilt and restored; with red brick in the tower and south transept (about 1840) and with Kentish ragstone (mainly 17th century). The Kentish ragstone, a rough-textured sandy limestone very variable in its weathering characteristics, was originally derived from the Lower Cretaceous Hythe Beds outcropping along the northern flanks of the Weald. You can occasionally see large fragments of an oyster Ostrea incorporated in the rock. However, All Saints Church comprises various other materials typically used by the Anglo-Saxons, such as septaria (iron-bearing calcareous nodules derived from the local Eocene London Clay), ferruginous (iron-cemented) gravel, flint (silexous nodules variously rounded or knapped and originally derived from the Chalk), but equally often derived from younger deposits such as marine and river terrace gravels), early Triassic ‘Bunter facies’ very hard quartzite cobbles and boulders (probably transported into East Anglia from the northwest during Pleistocene times), and re-used red Roman tiles. In the north nave buttresses there are even fragments of iron (furnace) slag, probably 19th century but difficult to date. Roman mortar (opus signinum) is commonly used (Figure 2).

Although it is reported that the church was only ‘slightly damaged’ in the Colchester earthquake of 1884, the damage was sufficient for the ultimate demolition of the north transept. The south chancel wall shows interesting cross-cutting fabric relationships (Figure 2). The blocked lancet window mentioned earlier and framed in Upper Greensand was partly cut, after being infilled, by an early Tudor brick priest’s door. This in turn was filled with Kentish ragstone and Roman tiles and then cut by a window that pre-dates 1634. Inside the chancel, excellent Jacobean panelling and stalls provide the last of these dates.

The sill of the priest’s door is of reddish Vitriparous limestone (‘Purbeck Marble’) imported from the Poole Harbour area of Dorset and probably represents a re-used tomb slab. In short the main materials used in this church are gravel with a ferruginous cement, Bunter quartzites, septarian nodules, flint, and Kentish ragstone. Minor items include Roman brick and tile, Roman mortar, iron slag, Upper Greensand, Purbeck Marble and other Jurassic limestones.

Figure 1. The GA party puzzle over the cross-cutting relationships evident in the south chancel wall of All Saints Church, Messing.

Figure 2. Detail of the south chancel wall, All Saints Church, Messing. Below the pen (150mm long), are re-used Roman brick fragments, and opus signinum (Roman mortar, with brick dust included).
Field Meetings

SHETLAND
We saw the Moho, and returned to tell the tale!

Well, yes, we did, from afar, but such was the breadth and depth of fascinating geology in the relatively small area of the Shetland archipelago, this was not really the highlight of the trip! Our leader, Allen Fraser, himself born and bred on Yell, and now by profession a meteorologist at Sullom Voe, had entitled the trip 'Shetland – Scotland’s Geology in Miniature', and an apt title it turned out to be. We’ll come again to the Moho later...

We had all been sent our pre-trip homework in the form of an overview of the evolution of Shetland. This set out, in a notable example of clear and well-illustrated exposition, the sequence of plate histories and their movements that have led to Shetland having perhaps the most concentrated yet richly diverse and complex geology to be found anywhere. Three of the major terranes that make up Scotland are to be found in close proximity on Shetland (Hebridean, North Highland and Grampian Highland) as well as its own Unst-Fetlar Terrane. These terranes have come together as a result of plate movements involving major transcurrent faults such as the Walls Boundary Fault (the northward extension of the Great Glen Fault) and major overthrusts, from pre-Moine to post-lapetus closure. Extensive and varied igneous activity at different times, from granite emplacement to volcanism, has added further dimensions to the complexities of sedimentary sequences, many thoroughly mangled by intense regional metamorphism as the tectonic history progressed. The islands are almost bare of tree cover, and soil cover is generally thin, so all this variety is well exposed for the touring geologist to inspect. As we travelled round the islands by coach and ferry, the rapidity of change in the geology was very evident through the coach windows.

Our party assembled at their base for the week – a comfortable guest house in Lerwick, with an excellent team of owners and staff who produced a wonderful sequence of meals for the group throughout our stay. We had received our excursion guide in advance, another superb piece of Allen’s work, which proved to be invaluable as we tried hard to keep abreast of the rapidly developing story throughout each day; it may be difficult for the GA to enable this standard of field guide to be maintained, but it would be well worth the effort and additional cost. The day-to-day arrangements were in the hands of a very capable local travel company; they provided us with a coach driver who took on the challenge of broadening the outlook of the party to encompass local history and folklore in a most entertaining manner, with a broad Shetland accent! The unique combination of Norse and Pict that underlies Shetland culture surely has its roots in the geological links between Scotland and Scandinavia! And to reflect this, the GA group was accompanied each day of the trip by members of the Shetland Field Studies Group, including Deborah Lamb, an expert amateur archaeologist, who gave us many valuable insights into the extensive pre-history of Shetland, including a guided tour of Jarlshof. Derek Rushton, a mineralogist turned crofter on Yell, contributed much from his wealth of knowledge about the unusual minerals found in Shetland. Our leader, as an experienced meteorologist, had booked a week of fine weather for this trip – and so it turned out to be, with but a few hours of rain in the whole time we were there.

Inclusion in granite. The craven igneous complex, about 400 million years old, has been cut and displaced by the Nesting fault giving rise to small outcrops such as that at Laxo where this example of granodiorite containing an abundance of xenoliths of hornblende-rich rock was found.

The Viking staurolite workings of Cuttand: Hydrothermal alteration of basic and ultrabasic pillow lavas has given rise to serpentinite and tale-magnesite rocks. The latter are known as staurolite or soapstone and is so a soft worked rock used from Neolithic times as a filler for making pottery. At Cuttand, Norse settlers worked this deposit to produce a wide range of objects, from fishing weights to cooking utensils and personal ornaments.

Eshaness volcanics. The cliffs of Eshaness provide superb cross sections through the lava flows and pyroclastic rocks on one flank of a large Upper Devonian volcano.
A member of the party inspects the spectacular Valayre augen gneiss which occurs at the edges of the boundary zone between the Moine and the Dalradian rocks across Shetland and forming part of the Scania Formation. The megacrysts are microcline and are in a schistose matrix.

We struggled hard to take in this complexity, but in the space of a day visit, most of us had to admit defeat and promise to return to give much more time to understanding the story. However, high up on a hillside, we saw a break of slope at the boundary between mantle rocks (harzburgite) and crustal rocks (dunite), perhaps representing what was once the base of a magma chamber and the top of the mantle below. Awesome! After this mental struggle, most of us were relieved to walk to the remains of the famous Hagdale chromite quarries, where we collected excellent specimens of massive chromite, as well as other chromium minerals. At several places in Shetland, metamorphism of ultrabasic rocks has produced serpentinite and tale-magnesite schist, or steatite – commonly known as soapstone. A famous locality for this is Catpund on Mainland, where the Vikings produced their equivalent of Pyrex bowls from the steatite deposits at the only known site of its kind in Britain. The original ultrabasic rocks at Catpund are thought to have been komatite lava flows, originating from well within the mantle, and these must have been some of the last such lava flows to occur (Lower Ordovician) as they are usually associated with earlier stages in the evolution of the Earth’s crust.

As already implied, the geology of Shetland lies on a Lewisian basement. So not surprisingly there are familiar Lewisian gneisses (e.g. on Yell), but in the Boundary Zone between the Moine and the Dalradian is found the spectacular Valayre Gneiss, an augen-gneiss in which megacrysts of microcline feldspar have grown in a schistose matrix. After this wonderful rock, the general run of schists, phyllites, psammites, semipelites and so on of the Dalradian seemed relatively monotonous!

We were constantly brought back from the complexities of regional metamorphism by the sudden appearance of igneous rocks. We visited a remarkable range of granitic intrusions. The Skaw granite on Unst is a foliated augen-granite, while the Aith-Spiggie Intrusion of west Mainland and Burra ranges from granodiorite through porphyritic adamellite, reminiscent of the Shap granite, into more basic monzonite and pyroxenite. The ‘inclusion granite’ of the Graven igneous complex contains abundant rounded hornblende xenoliths, while the large Northmaven intrusive complex features the Ronas Hill granophyre which forms much of the north-west corner of Mainland. We examined a similar profusion of intermediate and basic igneous rocks, but the climax of the igneous component has to be the Eshaness Volcanic Complex, possibly the best exposure of the anatomy of an ancient volcano in Britain, active in Devonian times. The dramatic sea-cliffs provide vividly clear sections through lava flows of various types, from anesites to ryholites, through great thicknesses of pyroclastic material, tufts, agglomerates and ignimbrites, and even some evidence for the existence of a parasitic cone on the flank of the main volcano. In contrast, the Muckle Hill vent on Bressay extruded a carbonate magma as well as intruding carbonate dykes and sills and creating extensive brecciation of the sedimentary rocks around the vent.

We had little time to look at the relatively recent Upper Devonian sedimentary rocks, but we did go on the island of Noss, an important

Sediments of the Old Red Sandstone basin of south-east mainland form spectacular cliffs near Eznaboe which reveal evidence of lacustrine and lake shoreline environments about 375 Ma. The Eznaboe Fish Beds represent the deeper lake bottom environment.

Clibberswick tale-quarry. This quarry on Unst is the only commercial tale-working in the British Isles.

The Walls Boundary fault is clearly visible at Back Sand near Ollaberry. The cliff face is covered with fault gouge about 0.5 m thick. The fault has a long and complex history resulting in an overall sinistril displacement of perhaps 100 km.
fossils, mainly worm trails and burrows, and the problems of their palaeoecology.

Throughout the tour we were frequently confronted by the relation between landscape features and surface geological processes. Tombolos? How many do you want? Three in a row across the mouth of Dales Voe, a classic U-shaped glacial valley with traces of ‘parallel roads’, and the grandest of all British tombolos, the shell-sand tombolo linking St Ninian’s Isle to Mainland. Glacial striae and erratics, caves and blowholes, spectacular geos and stacks, and the impressive Grind of the Navir, where the power of storm action has heaved ignimbrite blocks, weighing up to a tonne or more, from the cliffs and floated them over 100m inland to form an amazing storm beach of large imbricated blocks some 12m above sea level. And is the semi-circular shape of St. Magnus Bay, which plunges to more than 150m, a possible meteorite impact crater?

This account can only give a flavour of the remarkable variety that Allen Fraser introduced to us. Not enough space to do more than mention the dramatic exposure of the Walls Fault itself at Back Sand, or the amazing conglomerate and sand dyke at Scottie Holm, where Allen rounded off the trip with his final ‘puzzle site’. But hopefully enough has been said to give the reader a flavour of the incredible and fascinating variety that is Shetland geology, and to encourage more GA members to head north and explore it for themselves. Where else is there such an accessible concentration of excellent varied geology? And if you do, then the warmth of Shetland hospitality will be an added bonus, and perhaps you might even make contact with Allen, be infected by his enthusiasm as we were, and share his expertise. Our heartfelt thanks, therefore, to Allen for the immense amount of work he put into the preparations for this trip, and for leading us with unflagging energy and enthusiasm through the whole week.

Alastair and Zoe Fleming

For a brief and simple overview of Shetland geology, see:


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‘Geo’ near Eynaboe. Old Red Sandstone rocks of the southern end of mainland are well jointed and vulnerable to erosion from the sea with formation of caves, blowholes, and narrow tidal inlets known locally as Geos from the Norse ‘Gyva’.

However the weather was not at its best, with low cloud, so our visit was restricted to a single locality to debate the nature of extensive trace nature reserve with vast seabird colonies.

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Tombolo of St Ninian’s Isle. This shell-sand tombolo links St Ninian’s Island and Mainland. Formed by wave action sweeping sand and shingle round both sides of the island, it is 300 m long and the largest in the British Isles. A hoard of late Pictish silver objects was found in the ruins of St Ninian’s Chapel on the island in 1958.
Field Meetings

QUATERNARY SEA LEVEL CHANGES IN WEST SUSSEX
26th April 2003

Geology without the rocks was the order of the day for this trip with the geologist’s eye-of-faith being a useful requirement. 25 members and guests met at Arundel railway station from where Mark Roberts (of Boxgrove fame) led us at great speed through the highways and byways of West Sussex to viewpoints and exposures to demonstrate the results of recent research on the Quaternary raised beaches.

The purpose of this meeting was to understand the wider geological context of the Slindon Formation and overlying Eartham Formation. These are early Middle Pleistocene sediments deposited during the latter part of a major temperate and ensuing cold stage, respectively. The Slindon Formation is found at Boxgrove, the Palaeolithic site and home of the half-million year old Boxgrove Man, and is the highest of several raised beaches that form the West Sussex coastal plain. Human artefacts and a rich fauna are preserved in a narrow east-west strip only a few hundred metres wide that extends just 26 km from Arundel to north of Emsworth and no further. Why such a limited outcrop? - we were to find out.

Our first stop was a roadside viewpoint looking south to Hightown Hill, near Worthing. Hightown is a chalk anticlinal structure, separated from the main mass of the South Downs by an eroded Tertiary clay vale. Mark explained how the outcrop of the raised beach appeared to be bounded by Hightown Hill to the east and the similarly formed Portsdown Hill to the west. Whilst now much eroded, it is believed that half a million years ago these structures formed headlands that protected an embayment excavated into the softer Tertiary sediments.

Next stop was the Arundel Arboretum where we saw gravels of the Slindon Formation amongst the shrubbery, these deposits forming part of the raised beach sequence still preserved at high level. Racing westwards across the West Sussex countryside we stopped at various viewpoints to witness the break in slope that marks the position of the original chalk cliff, now much degraded, which formerly backed the beach. Microfossils from high chalk zones in debris from the beach deposits indicate that the cliffs once reached a massive 100 metres in height (similar to those of Beachy Head today). A stop at Slindon Bottom to view some recent research excavations provided the leader with an opportunity to describe the history of the raised beach studies and some of the early ideas on its formation.

Near Southleigh, north of Emsworth, we were shown a large patch of gravel that marks the most westerly occurrence of the raised beach. Many members were not convinced, as the deposit looked more like road gravel than a geological outcrop. However, borings and excavations in the area have proved otherwise. Retracing our steps eastwards, we then went to see some real geology at the Boxgrove site. Now much degraded and rapidly disappearing under landfill, we were fortunate to see some sections that had been cleaned up for the recent television series ‘Walking with Cavemen’. The sequence of beach deposits, cliff fall and overlying periglacial deposits were well demonstrated. A few worked flint waste flakes were found, but none of the handaxes for which the site is well known. Fortunately the site will not all totally disappear under landfill as English Heritage has purchased some of the land with plans for an archaeological study centre (note - the Boxgrove site is only accessible with pre-arranged permission).

So why is the Slindon raised beach limited to an area 26 km long by a few hundred metres wide? In the past half million years, coastal erosion accompanied by fluctuating sea level (falling overall) has removed the higher raised beach along the south coast except where the twin structures of Hightown Hill and Portsdown Hill (now much eroded themselves) provided protection to the sediments deposited in the enclosed bay. Even in this protected area, the raised beach has been eroded apart from a thin strip where cliff collapse and solifluction deposits buried and preserved the sediments in a thin wedge immediately adjacent to the cliff. Further away from the cliff, the flow of solifluction deposits off the South Downs (as climatic conditions deteriorated) completely scour away the beach deposits.

Ongoing research is now focusing on understanding the lateral variation in the sediments and their outcrop. It appears that, in some areas, rich archaeological layers may only be preserved under a very thin layer of topsoil unlike at Boxgrove where many metres of overburden were first removed. Also, whilst the sediments are generally mineralised and poor in organic remains, the studies have identified one area where cliff collapse included Reading Formation (Tertiary) clays. These sediments appear to have preserved rich organic levels and need to be investigated further.

Our thanks to Mark Roberts for leading a most interesting field meeting, arranging access to the sites, and producing an excellent handbook.

Mark Roberts describes the results of a number of research excavations such as this one in Slindon Bottom, near Chichester. The group soon became experts in recognising even the smallest traces of raised beach gravels. (Photographs - David Bone)

Section through the sands of the Slindon Formation and overlying solifluction gravels of the Eartham Formation at Boxgrove pit. One of the few remaining sections, this had recently been cleaned up for the ‘Walking with Cavemen’ television series as being described by Mark Roberts.

David Bone

Introduction

The small continent of Europe is home to several hundred million people living in over 50 nations and speaking dozens of different languages and dialects. This great melting pot of cultures has made our continent the special place it is today. No less diverse than its cultural heritage is the natural heritage of Europe. From the tundra of northern Scandinavia to the baking heat of southern Spain, Europe is home to many climates and a great diversity of habitats. The geodiversity of Europe is just as complex. The geological heritage of our continent ranges from ancient, stable areas such as the Fennoscandian shield to active plate margins such as those along the Mediterranean basin. Europe’s geological, natural and cultural heritage are, however, intimately linked. From earliest times (in human terms!), our patterns of settlement and cultural development have been linked to the continent’s geological resources. The great coal fields and iron deposits gave rise to the industrial revolution which in turn fed a great period of urbanisation in Europe. New nations, and indeed empires, were built on the proceeds obtained by exploiting our geological resource and, unfortunately, these resources too often become coveted by others and too often resulted in war.

Today, when we think of geological heritage in European terms many, naturally, think of places such as Iceland, the Alps, Mount Etna or the Giant’s Causeway. However, right across Europe there are rocks and landscapes that provide evidence of a particular moment in our geological history. Furthermore, now at the dawn of the 21st century, more people are becoming curious about this heritage. They want to learn more about it and go and see it for themselves.

Local communities across Europe are beginning to realise that their geological heritage can provide a source of sustainable economic benefit to their area. Rather than exploit this heritage in the non-renewable fashion of the past, there is an opportunity to manage it in a way that conserves it for the future. It is from this concept that the idea of European Geoparks developed.

History

The idea of bringing together the separate concepts of geological heritage and sustainable development is relatively new. Several people in Europe have worked at this idea for some 20 years. But it was only in 1997 that two individuals realised that such places might have more to gain by working together than separately. Guy Martini and Nickolas Zouros are both geologists and share a passion for bringing the wonders of Europe’s geological heritage to a greater public but doing so in a way that would bring sustainable economic benefit to local communities. They had been working on this concept in their own regions (Haute Provence in southern France and Lesvos in the Aegean, Greece) for several years but following their meeting in 1997, began to search for other European partners. They soon found some in the Vulkaneifel of western Germany and the Maestrazgo area of Aragón, Spain. Together in June 2000, and with the backing of European funding from the Leader IIC programme, they founded the European Geoparks Network. As well as sharing expertise and ideas, the four partners also agreed to embark on an expansion programme of the network. They sent out invitations to numerous areas and organisations across Europe, many of which attended the first European Geoparks Network meeting in Molinos, Maestrazgo, Spain in November 2000. Following this meeting several regions submitted application dossiers for membership and by the time of the second annual meeting (on Lesvos, October 2001), the European Geoparks Network had expanded to 12 members in 6 countries. It was also during 2001 that a special agreement of collaboration was signed with UNESCO’s Division of Earth Sciences which gave the European Geoparks Network the endorsement of UNESCO. Since then there have been four new additions, so at the time of writing (July 2003) the network has 16 members in eight European countries.
But what is a European Geopark?

Stated simply, a European Geopark is a territory which has a special and rich geological heritage, both from the national and European perspectives, but which also has a sustainable economic development strategy, usually supported by a European funding programme. The Geopark must have clearly defined boundaries and must be large enough to have the potential to bring real economic benefit to local communities. While a European Geopark must comprise a number of geological sites that are important in terms of their scientific value, other sites relating to the area’s natural and cultural heritage should also be promoted under the Geoparks brand. Additionally, while a Geopark has a vital role in promoting the sustainable economic development of an area, it must also play a vital role in educating the wider public about Earth Sciences in general and support scientific research into the geology of the area. Educating the public about Earth Sciences is seen as crucial to allowing local people to re-evaluate their geological heritage and to develop an appreciation of it.

How does the European Geoparks Network Operate?

One of the stated aims of the European Geoparks Network is to exchange ideas and expertise on promoting geological awareness and sustainable development. It is with this aim in mind that the members come together three times per year. Twice annually the network meets on its own while on the third occasion the network meets a few days in advance of the annual meeting which is open to everyone, members and non-members alike. These meetings promote the use of common tools such as the website (www.europeangeoparks.org), magazines, displays, events but also encourage members to develop exchanges or projects between smaller groups of geoparks. The meetings also discuss how to strengthen the network, expand it and publicise it. At the annual meeting, prospective applicants have the opportunity to meet current members and to inform the European Geoparks Network about their own regions.

The European Geoparks Network Charter is the basis for how the network and individual geoparks operate. This set of guidelines sets out clearly what is expected of members in return for being awarded the European Geoparks label. For instance, the network does not allow the sale or destruction of geological objects from sites within the Geopark where those sites are under the control of the Geopark. Also, the charter states that a European Geopark must be managed by a clearly defined structure that is able to enforce protection, enhancement and sustainable development policies within its territory.

Does the European Geoparks Network have an Organisational Structure?

The success of the European Geoparks Network depends entirely on the sum of the efforts put in by its constituent members. It is therefore vital that all members play an active role in the development of the network. Each Geopark therefore nominates two individuals to the European Geoparks Network Co-ordination Committee (in addition to a representative from UNESCO) that meets three times annually. Each committee member has a single vote and network decisions are taken on a majority basis. To supplement and help streamline the work of the co-ordination committee, an advisory committee of six individuals (including UNESCO) meets in advance of each meeting. Finally, to help ensure continuity of work between meetings, the European Geoparks Network has two overall co-ordinators: Dr Nickolas Zouros (Co-ordinator) and Dr Patrick J. McKeever (Vice Co-ordinator). The only decision-making part of the network is the Co-ordination Committee and only UNESCO have the power of veto on any decision reached by the network.

Left: Dramatic coastal scenery in the Copper Coast European Geopark, Co. Waterford, Ireland. An area of historical copper mining, the Copper Coast community groups are actively working together to renovate, preserve and promote their rich mining heritage.
Application for Membership of the European Geoparks Network

The membership process is fairly simple. An application dossier, not more than 30 pages long, should be submitted to the Co-ordination Committee, care of the Reserve Géologique de Haute-Provence in France. The dossier should include a description of the applicant territory (scientific, geographical, demographical, economical etc.). It should also outline the experience the personnel at the applicant Geopark have in using that area’s geological heritage to promote sustainable development and should clearly demonstrate the relative importance of geology and geodiversity to its overall development policy. Naturally, an applicant Geopark must also fully accept the points of the European Geoparks Network charter. The dossier is then reviewed by members of the European Geoparks Network Advisory and Co-ordination Committees and a final decision is taken at the next meeting of the Co-ordination Committee. Membership is given to all geoparks for a period of three years only. After this, membership is reviewed and will be renewed provided that the Geopark has been an active member of the network and can adequately demonstrate advances made in terms of the promotion of Earth Sciences and sustainable development over the last three-year period.

The Future

The European Geoparks Network is a young organisation but is already working to promote geological awareness and sustainable development on many fronts across Europe. New projects are now operating on a network-wide basis while groups of Geoparks are working together on a regional basis. Exchanges between Geoparks are also happening increasingly frequently and the dynamism of the network becomes more apparent with each meeting. But this is only the start. Members of the network are currently working with potential new members in several countries across Europe encouraging them and helping them with the application process. The vision of the network is of a series of Geoparks across Europe, linked by a common high quality standard, that not only provide visitors with an enjoyable, memorable and educational visit but also directly help the sustainable economic development of the Geoparks territory. The network hopes that the European Geoparks Network might provide a model that other areas in other continents might follow as they promote their own geological heritage. As the network motto states, “Using 4,500 million years of Earth History to build a sustainable future for all.”

Dr Patrick J McKeever
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Above: A geological time sculpture in the village of Stradbally in the Copper Coast European Geopark, Co. Waterford, Ireland. The sculpture acts as a focal point for the small village and, by using small bits of local rock embedded around the base together with a very brief notation about that rock’s origin, helps inform locals and visitors alike of the area’s geological heritage.

Right: President Mary McAleese talking to the artist who made the geological sculpture in Stradbally, in the Copper Coast European Geopark, Co. Waterford, Ireland, Ireland.
The Abberley and Malvern Hills Geopark

The Abberley and Malvern Hills form the backbone of an area illustrating over 500 million years of Earth history. Stratigraphy from Precambrian to Jurassic and Quaternary is represented with almost complete successions of the Silurian and Triassic periods present. A fine range of igneous, metamorphic and sedimentary rocks exists with some nationally important exposures. Silurian palaeontology is excellent and has formed the basis of much research. Indeed the whole area has been the centre of research and mapping from the days of Murchison through to the present day.

A group of committed individuals and organisations is putting together a proposal to designate this area of classical British geology as a Geopark, which will lead to international recognition. There is already a European Geopark Network with 15 member Geoparks. Application for membership has already been successfully achieved at two United Kingdom locations. Now it is the turn of this impressive west of England area to apply for recognition and designation.

A look at the geological map quickly illustrates the strong structural influence on the area. The underlying Precambrian basement with its associated faulting and folding runs in a north south direction and is the major influence on the geology of the proposed Geopark. Its impact can be seen from the southern margins of the Silurian Mill Hill infilling the surface expression of the Precambrian of the Malvern Hills and nearby Silurian hills of Ledbury and Suckley on to the Abberley Hills themselves. The associated major faulting then continues in to the Carboniferous rocks of the Wyre Forest. This geologically backbone to the area is flanked by a full Triassic succession to the east and a significant part of the Lower Devonian to the west. Furthermore the glacial and fluvial history of the Quaternary is written in the deposits and terraces of the Rivers Severn, Stour, Teme, Rea, Frome and Ledon.

The Geopark falls within the counties of Herefordshire, Gloucestershire, Shropshire and Worcestershire and covers over 1250 square kilometres. The geological and geomorphological significance of the area has been recognised for many years with 12 Sites of Special Scientific Interest (SSSI) and 62 Regionally Important Geological Sites (RIGS) present. There are also a number of Geological Conservation Review sites. All are protected within existing national legislation and County and District Structure and Local Plans. Within the same area there are many biological SSSIs and Special Wildlife Sites, the latter overseen by the four county Wildlife Trusts. Archaeological sites of importance are recorded and protected by the four County Archaeology Departments. This link to associated heritage plays an important part in the seamless understanding of the landscape.

The active and well-established Earth heritage groups carrying out recording and geocare are Herefordshire and Worcestershire Earth Heritage Trust, Gloucestershire Geocescervation Trust and Shropshire RIGS Group. These three very successful groups between them have 12 staff and 60 volunteers, have produced numerous publications and are continually consulted by County and District Councils and landowners for advice. They all have made major contributions to the environment and conservation policies of these councils.

Along with its rich wildlife and archaeology the area is blessed with a significant industrial and mining heritage. The Wyre Forest coalfield forming the northern part of the Geopark has a history stretching back many centuries. Mining ceased in 1972 but much evidence still remains in what is predominantly an area of forest and agriculture. The quarrying industry is evident throughout the Geopark and tells more of the geological story with many disused sites now providing excellent educational facilities, illustrating hard rock and unconsolidated sediments.

The underlying geology and the dynamic geomorphology are the predominant influences on soils and landscape character. The county landscape character assessments carried out by the county councils make much of this. The story of such diverse landscape is being brought to the public’s attention by various publications and in particular by Geology and Landscape Trails. In addition there are Building Stones Trails making the link, as part of public awareness programmes, with rocks and our every day lives. The trail publications are available in over 50 retail outlets within the area and at a number in other parts of the country including the Natural History Museum in London. These programmes of education are now well established with self-guiding trail publications, site interpretation panels and guided walks. A very successful element of the public awareness programme is the ‘Rock and Fossil Roadshow’, which is now in its third year with events in museums, libraries and community centres. It is aimed at schools and family groups. These participants and others have available to them web sites operated by the Earth heritage groups, providing much information about geology in the Geopark and sources of further information.

At a regional level it is useful to point out that the Geopark lies within a 2 hour drive or train journey of the West Midlands conurbation, the south Wales industrial area and the Bristol Bath urban region. Together these areas have a population in excess of 8 million. The potential for geotourism is great and for the education of the public in understanding and protecting Earth heritage, even greater.

A large number of visitors per year to the Geopark makes a considerable contribution to the local economy. Some elements are well established and very successful such as the production and sales of trail guides, replica fossils and ‘Geopark’ china mugs. Projects currently being developed are ‘board games, clothing and geology holidays. The latter is now being discussed with the hotel and accommodation industry with a view to establishing thematic geology holidays particularly in the out of season months of the year when there is a need for a boost in tourism. This geotourism project has much to focus on.

The four county councils and the district councils of Malvern Hills, Forest of Dean, Worcester, Wyre Forest, Wyche, Bewdley, Bridgnorth all have policies devoted to nature conservation. The Earth Heritage Groups have already established working relationships with these bodies as they have with English Nature. The latter has an ongoing programme of SSSI enhancement work over much of the Geopark and has played a major role in supporting the designation of RIGS. Other bodies associated with Earth heritage and active in the Geopark and where links already exist are the Malvern Hills Conservators, the Abberley Hills Preservation Society, The Countryside Agency, The Malvern Hills Area of Outstanding Natural Beauty, The National Trust, Gloucestershire Wildlife Trust, Herefordshire Nature Trust, Shropshire Wildlife Trust, Worcestershire Wildlife Trust, Shropshire Geographical Society, Woolhope Naturalists Field Club and The Cotteswold Field Club.

Shelsley Beauchamp church in the Teme valley. The tower is constructed of Triassic Sherwood Sandstone from outside the area and the nave is built of local Old Red Sandstone, probably Devonian St Mangius Group sandstones.
The coral Faviesites to be found in a wall and referred to in the 'Wyche and Parleice Geology and Landscape Trail' guide. This trail covers the Precambrian to the Pridoli of the Silurian on the western side of the Malvern Hills.

The Forestry Commission has a well established visitor centre in the Wyre Forest in the northern area of the Geopark and receives 200,000 visitors per year. This centre which tells the story about the forest and its wildlife is due to be considerably extended in the near future and has been offered as a location for the Geopark Visitor Centre. This offer has been taken up and now plans are being drawn up for the 'Geopark' content of the facility. It is an excellent location because there are many exposures of Carboniferous Coal Measure rocks and fossils within short distances of the Centre and the Abberley Hills, Severn Valley Railway and Bewdley Town trails are nearby. The Forestry Commission has agreed to undertake improvement works at exposures and new sites within the forest.

In addition the 'gateway towns' of Bewdley, Bromyard, Worcester, Tewkesbury and Ledbury and the central town of Great Malvern are already participating in the story of the geology of the Geopark. Most have Tourist Information Centres with geology and landscape trail guides for sale, some participate in rock and fossil roadshows and many have museums with important geological collections. This situation is being expanded to cater for thematic holidays in association with other heritage attractions in the area and the hotel and self-catering industry. Computer based geotourism information will be added to the network of Heritage Access points that are being developed by the county councils. These are web-based enquiry points in museums and libraries. Geopark information will be available as well as other heritage information. There are Heritage Centres at Bromyard and Ledbury that Herefordshire Council has indicated will be keen to provide Geopark interpretation and information. This offer will be taken up and will be a considerable boost to the rural economy. Similar centres in the other towns offer great opportunities to flag up geology to the general public.

Success in introducing the public and schoolchildren to geology and geomorphology depends on establishing good working relationships with landowners. Many RIGS and SSSIs in the area are on public land and therefore access is relatively easy. Some excellent geology is illustrated however on private land. Some of the best fossiliferous Silurian rocks are exposed in disused quarries such as Shavers End and Woodbury in the Abberley Hills. The landowners of these and many other quarries in the area have a policy of controlled access. There is ongoing scope for development of visitor facilities at some of the more spectacular sites, of which there are many. In addition the continuing programme of site enhancement, research and conservation depends on landowner co-operation. In this context organisations such as the Malvern Hills Conservators, Madresfield Estate and Eastnor Estate allow access to sites. Where the development of public awareness is dependent on landowner co-operation organisations such as the Severn Valley Railway have an established education programme and SVR is expanding its geology content within that. This heritage steam railway, which has 240,000 visitors per year, is the site, over the full 18 miles, of a Geology and Landscape Trail.

A party on a guided town trail as part of the Bewdley Festival, here looking at St Anne's church with a tower built of Carboniferous Coal Measure sandstone from nearby Forest of Wyre coalfield.

Dune bedded Permian Bridgnorth Sandstone - one of the 62 Regionally Important Geological Sites in the Geopark

In the southern part of the Geopark the Malvern Hills Area of Outstanding Natural Beauty has 1.5 million visitors per year. Figures are not available for the rest of the Geopark but a total number exceeding 2 million is not unlikely. It is one of the major policies of the newly formed Geopark Management Team to encourage these visitors to develop an interest in Earth heritage and to stay for a residential period while doing this. Part of this process will be to work closely with other organisations to produce sustainable site use.

There is a well-established Earth heritage funding programme within the Geopark. Major projects are in operation on public awareness, recording and conservation funded by the Heritage Lottery Fund, GETCo, Grundon Environmental Awards for All, English Nature, Severn Waste Environment Fund and LEADER+. Some projects are co-ordinated by the regional association of geoconservation groups - The Geology Trusts, which has a development officer looking after amongst other things, the expansion and training of the volunteer force within the area. The GT is developing a major bid looking at the building stones heritage of the Geopark.

The Management Team established to take the project forward has already met and agreed the first stages of its work. It consists of the Abberley Hills Preservation Society, the Forestry Commission, Gloucestershire Geocconservation Trust, Herefordshire and Worcestershire Earth Heritage Trust, Scenescetters, and University College Worcester. The ‘Action Plan’ to be produced by the Team will be built around the existing polices and guidelines of the authorities operational within the Geopark. Many of these policies already safeguard geological sites, are aimed at public access, encourage better public awareness and education, promote economic regeneration and tourism and involve the country Earth Heritage Groups in these processes. Thus the structure is already in place for the easy creation of the new Abberley and Malvern Hills Geopark.

**Dr Peter Oliver**

**Director**

**Herefordshire and Worcestershire Earth Heritage Trust** based at **University College Worcester**

18th June 2003

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**Right:** The famous Silurian/ Precambrian unconformity at Gullet Quarry in the Malvern Hills. Thin shales, limestones and conglomerates at the bottom of the picture rest on Malverns Complex schists. A large in situ clast can be seen at the top of the photograph.

**Below:** The cave dwellings in Triassic Wildmoor Sandstone at Stourport-on-Severn. The outcrop also forms a prominent river cliff of the River Severn.

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**Right:** Part of the impressive tufa deposit to be found at the junction of the Raglan Mudstone and St Maughan's Formations within the Devonian of the Teme valley.
The distinctive sandstone summit ridge of Cullegagh Mountain dominates the countryside of County Fermanagh in the south-west of Northern Ireland. Cullegagh Mountain is rich in globally and nationally rare habitats, including one of the best examples of oceanic blanket bog in Europe, as well as Northern Ireland’s finest upland limestone grassland landscape. Fermanagh District Council protects over 2,000 hectares of the bog, along with some of the best karst areas, in the Cullegagh Mountain Park. Scientific research into the geology, hydrology and geomorphology of Cullegagh has been ongoing since 1992 by the Limestone Research Group of the University of Huddersfield under Professor John Gunn.

The limestone on Cullegagh contains extensive cave systems including Marble Arch Caves. These caves were first explored in 1895 by the famous French speleologist Edouard Martel. Fermanagh District Council developed Marble Arch Caves as tourist caves in 1985 and they are now famous as one of Northern Ireland’s leading tourist sites having attracted some 890,000 visitors from more than 100 countries.

Cullegagh Mountain is composed of Carboniferous sandstones and shales overlying limestones. The lower Tyrone Group consists of a lime-dominated marine succession where sedimentation was controlled by rifting and localised subsidence. The upper Dartry Limestone Formation exhibits major sediment facies changes and rapid thickness variations over relatively short distances reflecting increased tectonic activity.

The overlying Leitrim Group consists of a sand-dominated sequence with a thick wedge of sandstone sandwiched between shallow-water carbonates with marine shales and fluviatile sandstones. These pass up into deeper-water marine shales that are followed by deltaic and turbiditic sandstone deposits.

The impermeable sandstones and shales of Cullegagh are drained by three rivers that flow to the Dartry Limestone. The rivers flow for some distance on the limestone before sinking underground to form Marble Arch Caves, which are a particularly fine cave system displaying complex speleogenesis, a fine array of speleothems and notable elastic sediment sequences. The showcase tour is widely regarded as world-class and is one of only a few tourist caves with an active mainstream cave passage.

The passages in Marble Arch Caves have formed along particular bedding horizons and fracture sets within the lower parts of the Dartry Limestone. Dissolution of limestone along these pathways originally occurred on a microscopic scale and later became enlarged through the evolution of the karst aquifer. The process is further complicated by an intrusive igneous dyke forming a vertical barrier to groundwater flows.

The rivers unite underground, emerging as the Cladagh River at the Marble Arch resurgence, which is in due discharges up to 10 cubic metres of water per second, making it one of the largest cave resurgences in Britain and Ireland. The Marble Arch is an impressive natural bridge spanning the river immediately downstream of the resurgence. It is a relict section of cave passage and, although limestone, may have been mistaken for marble in the past because sections have been polished by fast flowing water.

Over the years Marble Arch Caves have received international recognition for their management approach to sustainability in terms of conservation, development, education and the promotion of geotourism. This recognition culminated in 2001 when Marble Arch Caves and the integral Cullegagh Mountain Park were jointly awarded European Geopark status thus becoming the first European Geopark in the United Kingdom. Presently 15 European Geoparks have been formally recognised across Europe in Germany, Austria, France, Spain, Italy, Greece and Ireland.

Among other conditions, a European Geopark is defined as a territory that includes a particular geological heritage and a sustainable territorial development strategy supported by a European programme to promote development. It must have clearly defined boundaries and sufficient surface area for true regional economic development. A European Geopark must comprise a certain number of sites of particular importance in terms of their scientific quality, rarity, aesthetic appeal or educational value. The majority of sites present within a European Geopark must be part of the geological heritage, but their interest may also be archaeological, ecological, historical or cultural.

In April 2001 the European Geoparks Network signed an official agreement of collaboration with UNESCO (Division of Earth Sciences) placing the Network under the auspices of UNESCO. The Network has also been recognised by most of the European national geological surveys, while co-operation is under way with organisations such as the International Union for Geological Science.
We saw the first road sign shortly after leaving Mytilene (alternatively spelt as Mithilin), the island's airport and main town. Petrified Forest 90 km. As regular visitors to the smaller Greek islands, the distance seemed enormous, but the signing reflects the importance given to this European Geopark that was created in June 2000. In fact, there is little else on the island of Lesbos (Greek name, Lesvos) except some beautiful countryside, some history and plenty of holidaymakers.

Lesbos is located in the eastern Aegean, not far off the coast of Turkey (normally referred to locally as Asia Minor – they’re still not the best of neighbours). The Aegean is an area of active plate tectonics and volcanoes, including the well-known active volcano at Santorini. There are, however, abundant remains of previous volcanic episodes scattered around the numerous islands of the Aegean and, on Lesbos, craters and lava flows record the volcanic activity of some 20 million years ago. A number of hot springs, now converted into spas and hot baths, prove that there is still underground thermal activity in the area. Marketed on their therapeutic value due to their high mineral content, one bath we visited (temperature 33°C) was promoted to us as having “the right percentage of pH” and “traces of the non-harmful type of radioactivity” that were good for treating every ailment you care to mention.

In the course of the volcanic eruptions, volcanic ash and heavy rainfall resulted in huge mudflows of pyroclastic material that rapidly engulfed a dense forest area, which existed on the western part of the island. Subsequent hydrothermal circulation of silica-rich fluids resulted in the perfect replacement of the organic plant material. Bark, annual rings and internal structures are perfectly preserved. The petrified tree trunks are scattered over an area of 150,000 hectares, with major concentrations around the regions of Sigri, Antissa and Eresos. These are not just fallen trunks, but standing trees with root systems and soil horizons that represent the complete ecosystem fossilised in situ some 20 million years ago. Today, erosion (assisted by some excavation) has revealed impressive remains that include trunks up to 20 metres in length and others 3 metres in diameter. The fine grained muds have also yielded large numbers of perfectly preserved leaf imprints from many different species.

The Petrified Forest is an area of 286 hectares that has been fenced off and provided with around 3.2 km of trails that lead past the most impressive remains. The location in the extremely remote western part of the island makes car hire essential (or join one of the guided coach tours). However, there is no shop, no real information displayed and very little literature on sale. The specimens are numbered but not otherwise identified (a deliberate policy to avoid clutter) and there are no signs that indicate that there are, in fact, three separate trails. It was obvious that many casual visitors did not have a clue about what they were looking at. Fortunately, we had visited the Petrified Forest Museum the day before. This is actually located some distance away in the village of Sigri and appears to be ignored by most visitors – it is, however, extremely well worth visiting. Don’t miss it and go there before going to the Petrified Forest.

There is a guidebook (in English, see References) that could be purchased at the Museum. This describes the geology, flora and fauna, and specimen-by-specimen description of the exhibits along each trail. The most impressive remains comprise the ancestors of the Sequoia (giant redwood of today). The largest specimen is a trunk with root system and stands 7.02 metres high and has a circumference of 8.58 metres. Prior to burial, this tree stood over 100 metres high. The other remains are equally impressive with both ancestral pines and sequoias represented in abundance. The detail of preservation is phenomenal and the colours of the silicified wood are brilliant (red, yellow, green, blue, etc.).

Go in the springtime – it’s greener, cooler and, although there is some risk of rain, it avoids the baking heat and crowds of the main tourist season.

References
(An indispensable guide to the trails.)

David Bone

Fallen trunk 4.55 metres long and 1.20 metres in diameter of the Cypress family mainly exposed by natural erosion. The upper part is broken off in published illustrations, so has apparently been recently glued back on. Scale provided by Jessica Bone. (Photograph - David Bone)

Petrified trunk and roots of a conifer 1.5 metres high, 4.2 metres in circumference in growth position. A six metre long trunk of another specimen lies in the foreground. (Photograph - David Bone)
NEW GEOLOGY TRUSTS

This article describes the launch on May 1st of a new Umbrella organisation for Geoconservation - the "GEOLOGY TRUSTS".

This new organisation works in a similar way to its wildlife equivalent. It currently comprises six of the leading county-based Geoconservation and Earth Heritage Trusts in England - Gloucestershire, Herefordshire and Worcestershire, Shropshire, Warwickshire, Oxfordshire and Wiltshire. These county groups operated previously as the Western Association. The new collective organisation has been constituted and will shortly be registered as a charity.

The Geology Trusts through their partnership record over the last three years have developed an impressive record of work, achievement, and development. They are currently involved in their second collaborative project of producing detailed Geoconservation site management plans on a large number of key sites over the region. Previously they were working on a one year recording project where some 300 new sites were recorded in 12 months.

This success has been supported by even more significant gains by the individual trust members in their own organisations. Here all groups are now involved in funded project work with collectively twenty different pieces of project work being undertaken by the six trust members of the new group.

Financial Success

All of this comes at a price and fund raising has been the key to triggering this project work. Over the last three years the Geology Trusts (albeit under their old name Western Association) have initiated total project funding of some £260,000 for joint projects and individually the members with the support and encouragement of the umbrella organisation have raised a massive further £480,000.

These figures are testament to the benefits of partnership working and following good practice. They also bear out that focused work and "getting the job done" is what satisfies funders.

Main aims and Strategy

So what is the purpose and future drive of the organisation? The answer here lies in the benefits of partnership working. Two significant projects have already been approved as described above. There are even more ambitious ones in the pipeline both in their scope of work and budget. There is a massive gap in the public's perception of Earth Heritage and what the Geology Trusts aim to do. The onus is on local groups and partnerships and so far there is tangible progress. Future new projects will need to pick up on what benefits and educates non-geologists whilst allowing the more mundane functions of group work to continue. The days of being funded to go and record sites for databases are now gone and new and more imaginative projects will have to be produced. Again the lead should come from the wildlife sector where for some time they have been steering their work towards public benefit and widespread promotion of the whole span of nature conservation.

Acting and working professionally

It has become apparent that to make significant inroads to the conservation and promotion of our Earth Heritage we cannot continue with purely part-time enthusiastic input from weekend geologists. Groups need to take a lead from our wildlife colleagues and work with independent offices and paid contract or full time staff. Currently Geology Trust members use over 16 paid staff on a range of contracts. This allows for a regular level of service not only to funded contact programmes but also members of the groups, local agencies and Local Government authorities, and most importantly the public. All Geology Trust members are committed to working in this manner as well as maintaining high standards of health and safety, equal opportunities, and in-house training.
New Projects

The Geology Trusts have responded to this awareness and have major new projects in preparation concentrating on Building Stones and their impact on landscape and society and also on the impact and importance of geology and landscape in areas of outstanding natural beauty. The success here has been in the ability to attract funds that cover more than one specific group, or geographic area, and to be able to deliver work programmes that cover a large area that has wide strategic importance. These bids will be for substantial work programmes for up to five-year terms and will involve several hundred thousand pounds.

New efforts are also under way to promote and develop Geotourism in the trusts areas and this has been pioneered by the high quality trail series already under way in Herefordshire and Worcestershire and Gloucestershire. This is hopefully to be put onto another plane by the recent “Geopark” application for the Malvern and Abberley Hills. This includes large parts of four counties and is being driven by Geology Trust partners.

Strength in size

It is also a great benefit to be able to develop best practice and excellence and to test this and share information within a well co-ordinated network. In this respect Geology Trust partners have led the way in supporting the development of the existing Access database developed by Dr. Cheryl Jones at Herefordshire and Worcestershire Earth Heritage Trust and this may now be followed by geosites platform database using Filemaker software that runs from a CD. This is being developed by the Gloucestershire Geocentration Trust with support from other Geology Trust members and should be released this summer.

It is hoped to link in these data records with BGS recording and other site related work and research.

Another initiative is in providing a group insurance cover for all Geology Trust Group members. This is being set up with a leading national insurance company and will allow for cheaper premiums and a more comprehensive cover tailored for the diverse work of Geocentration organisations.

Growing for the future.

Already there are expressions of interest from other groups to join the Geology Trusts. All six current Trust members are looking to attract new members. So if you live in the area and are interested then please contact them individually or contact Julie Bundred, the Geology Trusts Development Officer, on 01905 855184, Email BUNDJ1@worcester.ac.uk. There is also a need to work with local and regional business and industry and there are clearly significant sponsorship and advertising opportunities with an organisation covering such a large area. In this regard it is hoped that good relationships will be advanced with quarry, landfill, and geotechnical operators in the region.

Mark Campbell

The Geology Trusts - A powerful argument for our existence.

NEW ZEALAND 2004

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In the following paragraphs, the Editor introduces the forthcoming articles in the Proceedings of the Geologists’ Association vol. 114 part 3 (2003).

The identification of hiatus surfaces, indicating time-breaks in the stratigraphic record, is important since they may reveal both transgressive and regressional flooding events, thereby aiding interpretation of the depositional history of a sedimentary basin. Their recognition may also assist correlation between widely separated sedimentary basins of the same age. In The development of hiatus surfaces in the Osmington Mills Ironstone Member of the Upper Jurassic Ringstead Formation of south Dorset, England, Margaret Williams describes the results of a detailed investigation of a unit which, in places, is the only Corallian bed in south Dorset to contain corals. She shows that this unit contains a number of hiatus surfaces of different temporal significance: although its top forms the previously-recognised Oxfordian-Kimmeridgian boundary, its base marks a sharp deepening in sea level, which has not previously been recognised.

In Key Middle Pleistocene localities of the Lower Thames: site conservation issues, recent research and report of a Geologists’ Association excursion, 8 July, 2000, David Bridgland, Danielle Schreve, Peter Allen and David Keen show that the Lower Thames terrace staircase may be regarded as one of the most complete, and best dated, archive of late Middle Pleistocene environmental change in Europe. Unfortunately, access to exposures of key sediments has been greatly reduced in recent years. Their paper combines a report of a GA visit to four such sites, all central to the recognition of the Oxygen Isotope stage (OIS) 9 and OIS 7 interglacials within the Lower Thames sequence, with discussion of the importance of these sites and related issues of conservation management; the results of a major literature review; and new investigations at a number of key localities.

Proceedings of the GA and History of Geology Group (Geological Society) joint meeting on ‘The Amateur in British Geology’ (2002) provide four papers in this issue:

In Thomas Hawkins and geological spectacles, Ralph O’Connor shows us that, far from his popular image as a madman, this 19th century fossil-collector and writer was a successful showman. His blend of dramatic writing and dry scientific fact served to awaken the imaginations of his wealthy audience of genteel collectors and savants of the 1830s and 40s, and assisted them to visualise a world once inhabited by the Plesiosaur and other ‘Sea-Dragons.’ O’Connor’s admirable analysis of Hawkins’s work suggests that, in spirit at least, it is not that far removed from the recreations of the recent BBC television series ‘Walking With Dinosaurs.’

Robert Davidson and Michael Newman introduce us to James Powrie, chronicler of the Scottish Lower Devonian, a gentleman scientist and palaeoecythologist, who described what were, in the 1860s, the earliest known articulated vertebrates from the fossil-bearing beds of the Old Red Sandstone.

In George Bellas Greenwood (1778-1855) — a lawyer in geologist’s clothes, Martina Kölbl-Ebert re-examines the archival record left behind by this influential man. Although Greenwood was one of the founders of the Geological Society of London, he was regarded by some of his contemporaries as a “drak” on the progress of geological science. Kölbl-Ebert looks behind the official façade of his publications, offices and honours, to reveal the influences which shaped his character and his attitude to science in general.

The case for and against human agency in the shaping of the chipped, or perhaps deliberately flaked, flints found in the Kent plateu and beneath the Crag in East Anglia caused furious debate among early students of the Palaeolithic. In Geology, archaeology, and the razing vortex of the “olith” controversy, Anne O’Connor examines the nature of this controversy. She discusses the experiments carried out by the amateur geologist Samuel Hazledine Warren (1872-1958) and others in an effort to introduce geological arguments into what had begun as a purely archaeological debate. The introduction of geological thinking was to result in the provision of a philosophical framework which would underpin Palaeolithic interpretation and classification.

Stratigraphical Procedure, edited and co-authored by P.F. Rawson and sixteen others, is the latest edition of the Geological Society of London’s guide to this topic, the first of which goes back to 1967. This edition is published in its Professional Handbook Series and is a product of its ‘Stratigraphy Commission.’ John Callomon’s Essay Review of this Handbook is a forensic examination of its contents which, ultimately, left him somewhat ‘disappointed’. The reasons for this are carefully documented in Callomon’s review, which will provide food for thought for all students and practitioners of this subject.

The Editor encourages the submission of obituary notices of sufficient length to do justice to their subjects’ character and achievements. In this issue, Jake Hancock writes on the late Michael Robert House (1930-2002) and the start of Devonian cyclostratigraphy and Bernard Leake on Professor John Graham Comrie Anderson, 1910-2002. Both men were distinguished academics. House’s work was principally concerned with Devonian stratigraphy and ammonoids and, as Hancock emphasises, he also carried out important early work on cyclostratigraphy. Anderson (elected FRSE in 1947) had great expertise in petrology, tectonics and, latterly, engineering geology, leaving behind him a lasting legacy ‘in the permanently stable dams and tunnels, robustly constructed, in wild surroundings, about which little or nothing is heard because they were so soundly built on secure foundations’.

Finally, Behind the scenes at the Nationaal Natuurhistorisch Museum, Leiden, and the Tyler Museum, Haarlem, the Netherlands by Steven Donovan and seven co-authors, is a well-illustrated account of a visit by GA members in the autumn of 2002 to the geological collections of two leading museums in The Netherlands. The museums are in towns easily reached by road or rail from Amsterdam or Den Haag (The Hague), and the authors’ descriptions of the collections should be sufficient to entice anyone thinking of visiting The Netherlands into making a detour to visit them.

Richard J. Howarth
Rockwatch News

One Saturday in early June saw an excited crowd of Rockwatchers and their parents keen to start the search for evidence of dinosaurs on the east coast of England around the Scarborough area; they were not disappointed! Thanks to leaders of the trip, Will Watts, the Dinosaur Coast Project Officer and Martin Whyte of Sheffield University, the group saw magnificent dinosaur footprints and let their imagination run wild, creating the scenario that lead to these traces of Jurassic dinosaur activity. Letters we received from youngsters who went on the trip were fulsome in their praise, for example: “The best part of the day was when we got to see the row of 8 bipedal triaenodon dinosaur footprints” and “The day was a great success, even my mum enjoyed it!”.

Rockwatch had a stand at the Peterborough Environment Show in mid-June on a scorching hot day. We met a lot of our Rockwatch members there and had a great day doing fossil rubbings and playing challenging word games under our shady awning. A little later in June Rockwatch spent a week at Derby University, under the umbrella of SciTec, as part of a week of science and technology activities for schools. Some 12,500 youngsters attended the festival during the week and Rockwatch was kept extremely busy doing fossil rubbings, sharing the secrets of geological impacts on the weekly shopping, identifying the roles of archaeologists, biologists and geologists and encouraging word skills whilst enhancing geological knowledge with our sophisticated word puzzles. On the Saturday, the festival was opened to families for a “Fun Day”. The Rockwatch team had lots of people keen to show their skills at making Jurassic and Carboniferous model scenes and fossil plaster casting. Lots of happy families took their geological masterpieces home with them as a memento of an exciting day.

Most of the places on our extensive summer field trips are now taken; more about these in the next issue of the Magazine.

Susan Brown

To find out more about Rockwatch:
E-mail: rockwatch@btinternet.com
Or write to: Rockwatch at the GA, Burlington House, Piccadilly, LONDON W1J 0DU
and you can visit our web site on: www.rockwatch.org.uk

Right, Martin Whyte demonstrates dinosaur footprints at Scarborough - others are examined by Crispin (below).

ANCIENT JORDAN

A GEOLOGICAL TOUR with HISTORICAL HIGHLIGHTS
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LEST WE FORGET
Geology of the D-Day landings in Normandy, 1944
Field Guide

Next year, 2004, will be the 60th Anniversary of what was to prove the greatest invasion from the sea during the Second World War, ultimately leading to the freedom of millions of people from an oppressive tyranny, but at a price. The beaches of Normandy saw much bloody sacrifice by all participating nations. The choice of Normandy was far from being fortuitous however and to a large degree depended on prior and often sur-
reptitious assessments of the nature of the offshore and onshore geology, the ability to overcome natural and man-made obstacles and the capability of sustaining the impetus of the Allied assault with near-complete aircover (the operational radius of the Spitfire was a crucial factor).

The Chief Engineer of the 21st Army Group (Major General Sir J. Drummond Inglis) later wrote — “We had, fortunately, long appreciated the importance of geology in modern war” — and it is with this in mind that we now have published a thorough geological/engineering geological guide to the immediate area of the D-Day landings. The authors are Colonel Ted Rose of Royal Holloway, University of London and Emeritus Professor Claude Fareyn of Caen University, both geologists very well-versed in military requirements. A group of British geologists were at the heart of terrain analysis for the landing sites and immediate hinterland before and subsequent to D-Day, including W.B.R. King (later Professor of Geology at Cambridge) and F.W. Shotton (later Professor of Geology at Birmingham), and it was they who identified suitable beaches, prospective areas for the rapid creation of temporary airfields, and sources of water and hardcore for road construction purposes. So it will not come as a surprise that the authors of the guide include a summary of such essential needs for a successful invasion and how they were achieved.

The coastal landings in Normandy on the morning of June 6th 1944 extended over some 80km from Ouistreham in the east to Ravenoville in the west and were divided into five sectors known as Sword, Juno and Gold (Anglo-Canadian) and Omaha and Utah (American). The authors deal with each of these sectors in turn, the itineraries covering the salient points of the geology, mainly the highly fossiliferous Middle to Upper Jurassic succession, which is about 250m thick and well-exposed in coastal cliffs. The Pleistocene mantle of limon (a loessic deposit) and the younger Pleistocene and Holocene sediments (gravels, sands, muds and peats) along the lower lying tracts of the coastal behaviour also covered. Classical localities to visit and stratigraphical successions to examine are interspersed with fascinating military and human information relevant to the landings and subsequent events, all illustrated by some 53 photographs, maps and line-
drawings. In other words this guide is a must for anyone, and that includes the leaders of school parties, who wish to understand the practicalities and put into a geological framework, one of the major events of World War 2.

(How to Buy: Guide £10.00; non-members £15.00 including postage)

Trevor Greensmith

GA GUIDES - Special offer to members see last issue for details - offer ends 1 Sept 2003
Above: Curtains and stalactites of calcite in the Crystal Palace show caves of Marble Arch. Below: A new chamber in Marble Arch Caves - Robert Thompson Photograph.