Geoscientist

The Fellowship magazine of The Geological Society of London | www.geolsoc.org.uk | Volume 22 No 6 | July 2012

THOMAS MORAN
Artist of the sublime

MONSTERS INK
Fossilised melanin unchanged

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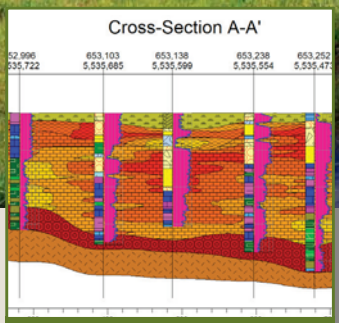

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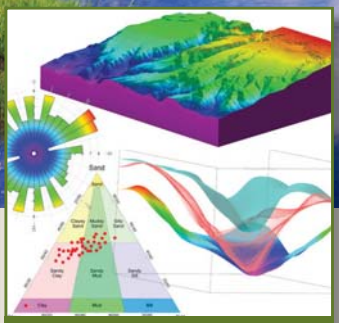

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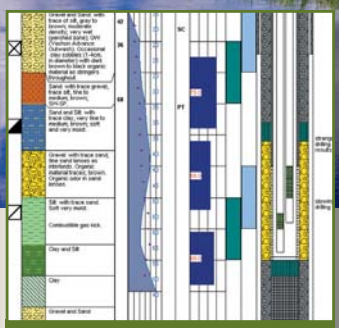

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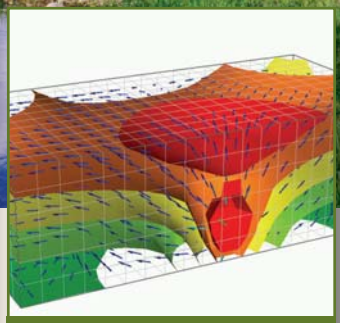

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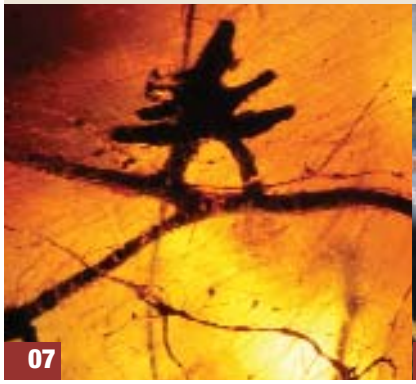

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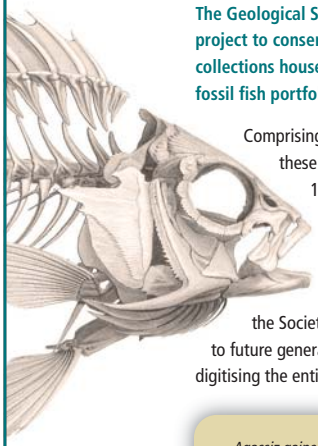

The Geological Society's Library needs your help with a new project to conserve and digitise one of the most important collections housed in the Geological Society's Archive: the fossil fish portfolio of Louis Agassiz (1807-1873).

Comprising nearly 2,000 watercolours and drawings, these images of fossil fish, dating from the 1830s-1860s, were copied from private and public collections around Europe, principally by the German artist Joseph Dinkel. For many years the drawings were kept in a trunk in the Museum and later in different places around the Society. We would now like to make them accessible to future generations of researchers by conserving and digitising the entire collection.

Agassiz gained international recognition as the leading figure on fossil ichthyology after the publication of the five volume Recherches sur les Poissons Fossiles, lavishly illustrated with 400 lithographic plates of fish (1833-1843). In 1836 he was awarded the Geological Society's Wollaston Medal.

How you can help

If you would like to help the Library and Archive in this project, a small contribution of £20 will allow us to carefully clean, conserve and digitise one fish. The names of all sponsors will be included in a roll of honour in the Archive and on our website. If you would like to make a more substantial contribution please contact us to discuss the options.

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THE CUTTING FACE OF A CROSSRAIL PROJECT TUNNEL BORING MACHINE (TBM). CROSSRAIL IS A NEW UNDERGROUND RAILWAY THROUGH LONDON

Front cover image: Crossrail

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OLYMPIC TORTURE

As the 70-day, 8000-mile Torch Relay brings the Olympic flame within reach of 95% of UK residents in the hands of 'inspirational people', there can be no doubt that the most exciting thing going on in the capital this month is - the Crossrail Project, subject of our main feature, by engineering geologist Ursula Lawrence.

But touching the other subject (incidentally, *Geoscientist* covered the engineering geology of the Olympic Park in May 2006, and do watch out for Sarah Day's special London podcasts while the flame still burns) we witnessed the arrival of said *ignis fatuus* on May 18. Since then there has been much complaint (at conferences of science communicators) that the so-called 'Cultural Olympiad', a set of nebulous parallel events featuring 'guys on stilts', ought to have been named the 'Arts Olympiad'. And one opportunity to include some science was well and truly lost on that day, as the apparatus in which the flame was carried to Land's End (before being transferred to the famous torch) was described by BBC World's commentator as "a specially designed golden lantern".

Why the helicopter in which it arrived was not described as "a specially designed heavier-than-air flying machine" I cannot imagine; but I suspect it was because the commentator knew a helicopter when she saw one, but had never seen a Davy Lamp in her life.

Now, I recognise that not everyone comes from a mining background or was brought up in a coal basin. But Humphry Davy's Safety Lamp surely ranks among the greatest inventions of all time – its metal gauze principle given to the world freely by an inventor too high-minded to apply for a patent. Ignorance of it may say something about the decline of mining, or changes in the way chemistry and physics are taught; but it rankles all the more around these parts, because Sir Humphry Davy (1778-1829) was one of the 13 founders of - The Geological Society.

I was in France in 1998, when the French national stadium, the *Stade de France*, was opened. It was built on heavily polluted brownfield land in Saint-Denis, Paris - and I greatly admired the way that a TV science programme for children, *C'est pas sorcier* ('It's not magic' – FR3), devoted an entire programme to its planning and design, land remediation, and construction.

And that, in a nutshell, is how enthusiasm for the Olympics could have been used to feed interest in the amazing geotechnical and other scientific aspects of this worldwide sporting event. But nobody thought to ask. And we have got guys on stilts instead.

DR TED NIELD EDITOR

Not taking the shilling

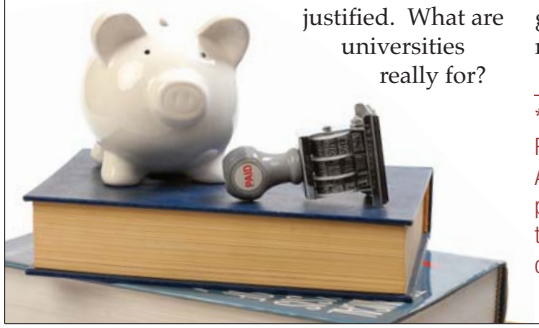
BY JOHN BUCKERIDGE

The 'privileged academic' is an easy target – and while public and politicians expect us to 'pay our way', the consequences could be dire, says **John Buckeridge***

Increasingly, we as academics are expected to produce research outputs that can be quickly adopted by industry or business. In Australia as most western countries, the push is now not only to publish and ensure we are "relevant" but also to bring in supporting grants as pledges that our work is truly 'important'. But focusing on grants rather than publications is a disingenuous objective. Not surprisingly, in many universities, especially in science and engineering schools, academics are becoming little more than consultants, carrying out tasks that may well improve process (and this is debatable) but no longer push the boundaries of knowledge.

By measuring performance through grants, university administrators believe they obtain a true measure of academic value. In some Australian universities there is now a scale that sets the level of grant funding that staff at each grade must win – for full professors, well into six figures! In a discussion with a university manager recently, I indicated that large grants were not likely to assist much in palaeobiology - indeed, palaeontologists succeed through observation, reflection, discussion and analysis. This takes time, but not necessarily vats of money. The corollary is that we are very capable of doing interesting science.

For many years there has been concern about the poor productivity of some academics, some of whom had apparently failed to publish a single paper over long periods. However, adopting punitive systems to bring into line a minority is an exercise in poor management and cannot be tolerated or justified. What are universities really for?



Surely nurturing scholarship and excellence; but should they be consultancies for business and industry? If they try to be all of these, what are the consequences?

One is a loss of impartiality. If academics require industry support for grants (as is certainly the case in Australia), then we must serve these industries. This places severe strain on that old, established role of the university as critic and conscience of society.

PUBLISH OR PERISH

Society must learn the lessons of the past. The "publish or perish" doctrine will only raise the spectre of Vishwar Gupta, the Indian geologist whose flawed work has been exposed by New South Welshman Professor John Talent. What could drive anyone to do this? The bauble fame was a key driver. For a time Gupta's publications certainly enhanced his status, but the ultimate exposure of deception left a very sour taste, especially among those who were duped and undeservedly tarred as co-authors. It also damaged the public integrity of scientists.

An environment for science must be free of bias or unreasonable pressure. Universities need to demonstrate that they contribute to public good, and applied science, medicine and engineering certainly achieve this. However a good university also seeks truths and pushes boundaries, unencumbered by allegiances. We must ensure that the easy road of delivering what the client asks, cannot be a rationale for academe – it is an abrogation of a higher responsibility. Rewarding academics upon grant income is simplistic, intellectually naïve and morally abhorrent.

* **John Buckeridge** is Professor of Natural Resources Engineering, RMIT University, Melbourne, Australia, lecturing professional ethics and palaeobiology. He is the immediate past President of the International Union of Biological Sciences, and chair of its Ethics Commission

SOAPBOX CALLING!

Soapbox is open to contributions from all Fellows. You can always write a letter to the Editor, of course: but perhaps you feel you need more space?

If you can write it entertainingly in **500 words**, the Editor would like to hear from you.

Email your piece, and a self-portrait, to **ted.nield@geolsoc.org.uk**. Copy can only be accepted electronically. No diagrams, tables or other illustrations please.

Pictures should be of print quality – as a rule of thumb, anything over a few hundred kilobytes should do.

Precedence will always be given to more topical contributions. Any one contributor may not appear more often than once per volume (once every 12 months).

> "WHAT ARE UNIVERSITIES REALLY FOR? SURELY NURTURING SCHOLARSHIP AND EXCELLENCE; BUT SHOULD THEY BE CONSULTANCIES FOR BUSINESS AND INDUSTRY?"
> **John Buckeridge**

Monster's ink indelible

In 160 million years there hasn't been any change in the chemistry of squid ink - living proof that, if a structure remains optimal, natural selection is conservative. **Ted Nield** reports

PALAEONTOLOGY

We tend to associate the term 'natural selection' with 'evolution', but it would be a mistake to think of it as necessarily forcing evolutionary change. The fact is that if things don't need to change, they stay the same – and natural selection makes sure they do. An international team of researchers has found that two ink sacs from 160-million-year-old giant cephalopod fossils, discovered two years ago by Phillip Wilby of the British Geological Survey in Christian Malford, Wiltshire, contain the pigment melanin that is chemically identical to that found in the modern cuttlefish. This extremely rare example of organic material being preserved intact for hundreds of millions of years suggests that the ink-screen escape mechanism employed by cephalopods has not changed in all that time.

"Though the other organic components of the cephalopod we studied are long gone, we've discovered through a variety of research methods that the melanin has remained in a condition that could be studied in exquisite detail," said Professor John Simon, one of the study authors, at the University of Virginia.

> "I WOULD ARGUE THAT THE PIGMENTATION IN THIS CLASS OF ANIMALS HAS NOT EVOLVED IN 160 MILLION YEARS"
> **John Simon**

One of the ink sacs studied was the only intact ink-sac ever found. Wilby sent samples to Simon and to Japanese chemist Shoskue Ito, both melanin experts. They then engaged research colleagues in the USA, UK, Japan and India to investigate the samples using a combination of direct, high-resolution chemical techniques to determine whether or not the melanin had been preserved. They then compared the chemical composition of the fossil melanin to that of the common cuttlefish, *Sepia officinalis*.

Above: The ink sac from a 160Ma giant cephalopod fossil contains melanin; essentially identical to melanin found in the modern cuttlefish

Simon told reporters: "It's close enough that I would argue that the pigmentation in this class of animals has not evolved in 160 million years. The whole machinery apparently has been locked in time and passed down through succeeding generations of cuttlefish. It's a very optimised system for this animal and has been optimised for a long time."

The melanin molecule is extremely resistant, Simon explains. "Out of all of the organic pigments in living systems, melanin has the highest odds of being found in the fossil record" he says. "That attribute also makes it a challenge to study. We had to use innovative methods from chemistry, biology and physics to isolate the melanin from the inorganic material."

The researchers cross-checked their work using complementary experiments designed to capitalise on various molecular features unique to melanin, and determined its molecular morphology and chemical composition. This combination of in-depth, multidisciplinary techniques is not normally used by paleontologists to study fossil samples.

"I think the strength of this paper is that it is not tied to a single method" Simon told *Geoscientist*. "Any one technique would have brought some insights, but potentially more questions than insights. It was really the more holistic approach that fully characterised it and allowed us to actually do a real comparison between what existed during the Jurassic period and what exists now.

"It's also given us a handle on ways of identifying organic components in fossils that might have been missed using standard methods."

REFERENCES

1 **Keely Glass, Shosuke Ito, Philip R Wilby, Takayuki Sota, Atsushi Nakamura, C Russell Bowers, Jakob Vinther, Suryendu Dutta, Roger Summons, Derek E G Briggs, Kazumasa Wakamatsu, and John D Simon** Direct chemical evidence for eumelanin pigment from the Jurassic period. PNAS, May 21, 2012 DOI: 10.1073/pnas.1118448109

Early dawn sheds light on Vesta

Joe McCall has doubts about the impact origin of a major structure discovered on the surface of the asteroid Vesta, recently visited by the 'Dawn' space probe

ASTEROID GEOLOGY

Initial results of the Dawn mission to Vesta (diameter 530 km) and Ceres (a dwarf planet) have been published[1]. Vesta, now visited, has revealed a huge circular 475km diameter negative structure centred on the south pole with a central peak ~23km high (greater than Olympus Mons volcano on Mars!). The structure, named Rheasilva (after a vestal virgin), is thought by the authors to be an impact structure and occupies ~80% of the diameter of the asteroid. I regard this as doubtful: firstly, such a huge impact would surely have blown Vesta apart, and I personally doubt whether Mare Imbrium, likely analogous on the Moon, and with no central peak, is an impact structure. I personally think both are more likely to be endogenous structures.

A unique feature is a series of equatorial 10km-wide trough-and-ridge girdles, a completely novel type of structure on a solar system body, and believed to relate to Rheasilva. The asteroid is heavily cratered and there is a multitude of small, fresh bowls, later than the girdles (all likely contemporary) as well as a few older craters. Several of the larger bowl craters have small central craters within.

> "UNTIL SAMPLES ARE RECOVERED FROM THE SURFACE, THERE IS NO CERTAINTY OF THESE ATTRIBUTIONS, AND THERE MAY BE SURPRISES!"
> **Joe McCall**

Vesta is widely believed to be a mixture of the HED meteorite types: eucrite (basaltic), diogenite (ultramafic, almost monomineralic with bronzite) and howardite (a brecciated mixture of the two). Radiometric dating has constrained these achondrite meteorites' differentiation to a few hundred million years after the first condensates of our solar system. These determinations of the likely meteoritic analogues stem mainly from spectrography and geochemical modelling.

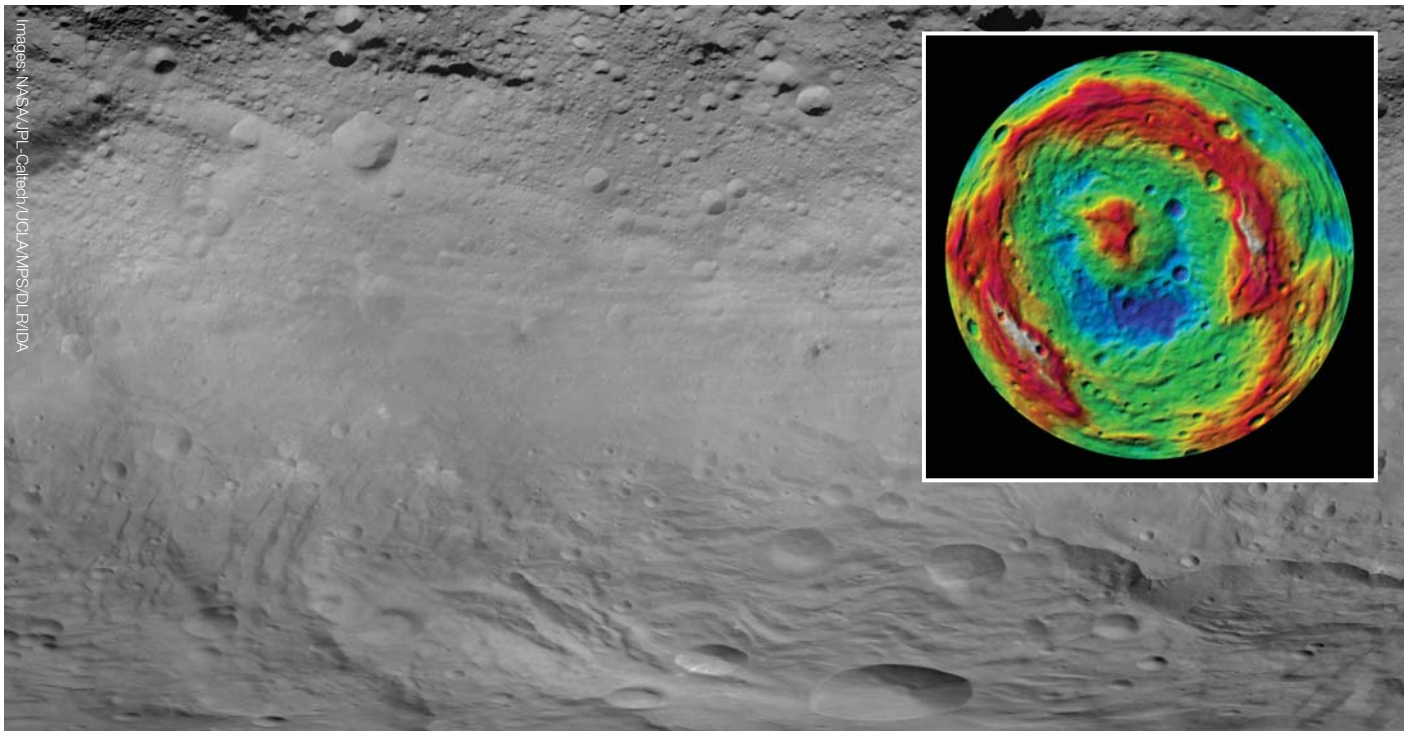
Below: The large trough and ridge structures in Vesta's equatorial region

Inset: False colour map of the south pole of Vesta. -22km is blue to +17 km red to white from mean elevation

The evidence from Dawn indicates that Rheasilva exposes mainly ultramafic rocks, supporting the idea that diogenites form the lower crust. The remainder of the crust seems to be enriched in basaltic rocks and may well expose mainly eucrite and howardite. However, until samples are recovered from the surface, there is no certainty of these attributions, and there may be surprises! Spectrographic determinations do not establish the exact mineralogy and modelling may always miss the mark because of the wrong initial input? At time of writing Dawn is going to go closer to Vesta and obtain close up images, before it moves on to the larger Ceres.

REFERENCES

1 **Corrigan, C, Beck, A, McCoy, T** 2012 Missions to asteroids: journeying to the beginning of our solar system. Elements 8(1), 9-10.



Images: NASA/JPL-Caltech/UCLA/MPS/DLR/IDA

Joe McCall, Geoscientist's longest-serving Editorial Board member and Distinguished Service Medallist 2011, reflects on geology in the news

McCALL'S WORLD

Fossilised fungi in deep biosphere?

New discoveries in Eocene subsea cores extend the realm of the fungi, only scantily represented in the fossil record, into the deep biosphere, suggests **Joe McCall**

Image: Alexander Schmidt, University of Göttingen

PALAEOMYCOLOGY

Richard Fortey's *Survivors*[1] is a book full of fascinating detail. In it, the author perceptively remarks: "the origins of fungi do indeed root back to the time of the stromatolites when the single-celled protists began to diverge into their several kinds". Fungi are indeed the elusive kingdom, since they do not normally fossilise at all - though there is a single example in amber (picture), and from the Rhynie Chert. They certainly originated in the Proterozoic, but opinions differ between ~2 billion years and 750 million years: the former seeming more likely, now that eukaryotes have been recognised confidently in Gabon at ~ 2100Ma[2] . The first fungi undoubtedly dwelt in the sea[1], though logically they must have colonised the land before the first plants.

Hitherto, it has been assumed that only prokaryotes (bacteria and archaea, single celled) occupy the deep biosphere beneath the sea floor, conditions being too rigorous for other than such extremophiles. However, fossilised filamentous organisms have now been found in drill core through sub-sea floor basalts in ODQ 157 at the Emperor Sea Mounts, Pacific Ocean[3]. These fossilised fungi are observed in carbonate-filled veins and vesicles. X-ray tomographic miscroscopy has revealed fungal morphology, while and possible chitin has been detected by staining. This discovery must surely change our conception that the deep biosphere on the sea-floor can only be occupied by prokaryotes.

Above: Fossil fungal hyphae in amber

REFERENCES

1 **Fortey, R** 2011. Survivors. Harper Press, 336 pp.

2 **McCall, G J H** 2010. The first eukaryotes. Geoscientist 20(12), 12.

3 **Ivarsson, M, Bengston, S, Belivanova, V, Stampanoni, M, Marone, F, Tehler, A** 2012. (Abstract) Fossilized fungi in subseafloor Eocene basalts http://geology.gsapubs.org/content/early/2012/o1/05/G32590.1.abstract

SOCIETY NEWS

SOMETHING WIKI THIS WAY COMES...

What are the most visited websites in the world? To answer this question, most of us will refer to Wikipedia. Sarah Day reports on a training day for Wiki geo-editors.

While Wikipedia hasn't quite achieved the stratospheric heights of Facebook and Google, it is rarely out of the top 10 most visited websites. Since its launch in 2001, Wikipedia has been known as the scourge of teachers and lecturers, with students constantly being reminded that cut and pasting a wiki article isn't the same as doing actual research. But is it?

You can see why they're worried: anyone can edit it, and there's a lot of fun to be had in doing so. But as the editorial process becomes more stringent, attitudes to Wikipedia are changing. Some universities are even including Wikipedia-editing as part of their courses, to encourage students to share what they've learned. The site isn't just a source of knowledge; the editing itself can be a learning process, as well as an opportunity to practise communicating complicated topics to a general audience.

It's not just accuracy that needs improving - some articles on scientific subjects include far too much detail and technical jargon, contradicting the site's aim to make knowledge freely accessible. There are over 8000 geology articles, reaching a huge audience - the 'volcano' page receives over 160,000 hits per month. With so much traffic around the world, the consequences of errors or misleading articles can be huge.

ACCURACY

Wikimedia UK is collaborating with scientific organisations to encourage more members to contribute to Wikipedia articles. GSL Fellow Brian Whalley took part in a recent event at Burlington House. He says: " We had the opportunity to discuss Wikipedia's rules about neutrality, referencing and correcting entries, as well as using a 'sandbox' or trial area to produce entries. Behind the scenes data show that many entries of interest to geoscientists are 'stubs', 'deemed too short to provide encyclopaedic coverage of a subject'. Becoming a geoscientific Wikipedian would greatly enhance Wikipedia's geological coverage."

FEATURED

All Wikipedia articles are rated for accuracy, neutrality, completeness and style. 'Featured articles' (FA) are those which have come out on top, after being rated by Wikipedia editors. After this, articles are graded A to C, or classified as 'start' or 'stub' articles that need completing. It's easy to access the articles listed in the table, or have a look at a project which is more specific to your expertise, such as palaeontology, or volcanoes.

Despite the occasional well publicised errors and hoaxes, the site's commitment to providing accessible and high quality information is the reason for its popularity. The more experts engage, the better the information will be, and without their input, others less qualified will fill the gap. The responsibility lies with those who know better to get there first.

A longer version of this piece is available Online

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If you wish to take advantage of this offer, the deadline for receipt of your order is 10 August 2012. To sign up please contact the Fellowship Department at **membership@geolsoc.org.uk**

Society Awards

Fellows of the Society are invited to submit nominations for the Society's Awards for 2013 to the Awards Committee. Full details of how to make nominations are on the website at **www.geolsoc.org.uk/gsl/awards**. Nominations must be received at the Society no later than Friday 5 October 2012

Olympic fun & games

Burlington House will remain open during the Olympic Games (27 July – 12 August and 29 August – 9 September). Although staff wish to provide a full service to Fellows, particularly with regard to the Library, there may be disruption to travel which will mean that opening hours may alter at short notice. So that you don't have a wasted journey, please ring the Society before setting out. Fellows are recommended to look at **www.tfl.gov.uk/gettingaround/** from where there is a link to London 2012 Games.

FUTURE MEETINGS

Dates for meetings of Council and Ordinary General Meetings until June 2013 shall be as follows:

- **2012:** 26 September, 28 November
- **2013:** 6 February (1500); 10 April

[CITY LINKS]

Demystifying exploration for the City

Peter Dolan and Colin Summerhayes of the Development and Fundraising Committee have begun building contacts with city firms.

The Society's newly formed City of London Geoscience Forum (CLGF) held its third meeting at the Society's apartments on 20 April 2012. With the title *'Demystifying Emerging Exploration Techniques'*, the meeting was kindly sponsored by one of our Corporate Affiliates, Ophir Energy plc. The event was designed for an invited audience of oil & gas analysts and investment fund managers, who are respectively concerned with evaluating and valuing oil and gas exploration and production companies, and making investments in such companies. To carry out their tasks most effectively they need to understand both the inherent prospectivity of companies' portfolios of acreage and the technical and operational risks associated with 'monetising' the assets.

To assist in this understanding, the CLGF brought together a slate of eight independent service company presenters to speak on leading edge developments in seismic acquisition and processing, non-seismic geophysical techniques, pressure prediction, drilling innovations and the rigour required to produce a trustworthy Competent Person's Report (CPR). For those not familiar with these documents, a CPR report is compiled by qualified consultants who are accepted by all parties with a vested interest as being those most qualified to opine independently on the merits and valuation of a company's assets. The speakers all spoke to the same format: what is new, what is promised, what are the pitfalls and how can the new methods help to inform an investment decision.

In discussions during lunch, the value of chartering geoscientists came to the fore, with some interest being displayed in the guarantee of standards provided to companies by CPR authors having chartered status. Future meetings will extend the Society's outreach to this sector, which ultimately funds the development of natural resources and provides some, if not most, of the *raison d'être* for our profession and Society.

FROM THE LIBRARY

The library is open to visitors Monday-Friday 0930-1730.

For a list of new acquisitions click the appropriate link from http://www.geolsoc.org.uk/gsl/info

Sponsor a Fish: new ways to help

It's a year since the library launched its 'Sponsor a fish' appeal, and the results are - forgive us – off the scale. Michael McKimm reports

The Library and Archive wishes to thank all those who have donated to the appeal to conserve and digitise nearly 2000 drawings from the fossil fish collection of Louis Agassiz (1807–1873). Through the generosity of Fellows, Friends and members of the public from around the world we have raised over £6000, a brilliant achievement for the first year of the appeal and one we hope to build on in the year to come.

Many fish were sponsored in memory of friends or relatives who had a particular interest in fossil ichthyology, while other donations were made as birthday, retirement and even wedding gifts (on such occasions a certificate is provided). We still have some way to go, however, as £20,000 is required to clean, conserve and digitise all of the drawings fully, so making them available to new groups of researchers for generations to come. If you would like to sponsor a fish for £20, please send a cheque to the Library, or call **020 7432 0999** to pay by card. Larger donations are greatly welcomed.

Fundraising, one could argue, has a fossil history all, its own – Agassiz himself was no stranger to it. For it was through the benefaction of many notable figures that the scientist, arriving in Neuchatel, Switzerland at the age of 25, was able to begin work on what would be his seminal opus, *Recherches sur les poissons fossiles*. In it he would 'present Fishes through nearly all the geological ages, almost from the beginning of life'[2]. The magnitude of Agassiz's plans was daunting, but with financial assistance from the King of Prussia, the Earl of Enniskillen, Sir Francis Egerton, friends and family, as well as the Geological Society, he created a lithographic establishment in Neuchatel where he could keep 'draughtsmen of superior talent, trained by himself to the greatest accuracy' in permanent employ[2].

These artists, including J C Weber, Joseph Dinkel and Auguste Sonrel, drew the vivid and detailed watercolours which we now seek to conserve and digitise. Using the relatively new technique of lithography – where the mutual repulsion of oil and water on a slab of limestone creates an image to be printed – the drawings were reproduced to form the Atlas of nearly 400 plates that would accompany Agassiz's important five-volume book.

References: **1.** Guyot, *Arnold Memoir of Louis Agassiz*, 1807-1873 Read before the National Academy, April, 1878 **2.** Ibid

Lithographic Prints For Sale

We are now giving you a rare opportunity to purchase one of the original lithographic prints from a copy of Agassiz's *Recherches sur les poissons fossiles*, which have been kindly offered by a Fellow of the Society to raise funds for the appeal. Please bear in mind that these are original lithographs from circa 1840 and show some natural wear and tear due to their age. Why not view them online now at **www.geolsoc.org.uk/sponsorafish** and become the proud owner of a slice of fossil fish history?

CROSSRAIL
THE ENGINEERING GEOLOGY

The Crossrail project, the greatest tunnelling project beneath the Capital in almost a century, is changing the face of London's geology, says **Ursula Lawrence***

The Crossrail project is a new underground railway through the heart of London. It will connect with 110km of new or upgraded sections of surface rail to Maidenhead, Shenfield and Abbey Wood. These upgrade and construction works are being delivered, on behalf of Crossrail, by Network Rail. The central tunnelled section comprises 21 kilometres of twin-bore, 7.2m-diameter tunnels, 11km of Sprayed Concrete Lined (SCL) tunnels at five new underground stations, cross-passages and crossovers, three new box stations, and a refurbished Victorian railway tunnel.

Trains from the Great Western Railway will run underground at Royal Oak, west of Paddington and pass through new stations at Paddington, Bond Street, Tottenham Court Road, Farringdon, Liverpool Street and Whitechapel. At Stepney Green a crossover cavern will be constructed, allowing the route to split.

Trains heading south east will pass through a new station at Canary Wharf to emerge at Victoria Dock Portal in docklands and allowing trains to call at Custom House for the Excel exhibition centre. The former North London Line has been reused, and the 140 year old cut-and-cover Connaught Tunnel refurbished. Trains will cross under the River Thames at North Woolwich to pass through the new station at Woolwich Arsenal before emerging at Plumstead on to the North Kent Line and terminating at Abbey Wood.

Trains heading north east from Stepney Green will emerge at Pudding Mill Lane onto the Great Eastern railway, the first stop being Stratford and the last Shenfield, Essex. In addition to the nine stations and five portals, Crossrail includes five permanent shafts for ventilation, maintenance and emergency access.

RUNNING TUNNELS

The running tunnels will be formed by eight closed-face tunnel boring machines (TBMs). Six of these will be earth pressure balance machines (EPBMs), which will be used for most tunnels. EPBMs are closed-face TBMs specially designed to cope with soft ground conditions with loose sedimentary deposits, large boulders, and a high water table. The other two will be Slurry Shield TBMs, which can cope with variable soft ground with high ground water flows, and will be used for the Thames Tunnel between Plumstead and North Woolwich.

Tunneling began in May 2012 from Royal Oak portal with two TBMs (Phyllis and Ada) tunnelling towards the eastern end of Farringdon Station. Passengers travelling west out of Paddington will have seen the TBMs being prepared, under the flyover. Three of the TBMs are due to set out from a new shaft at Limmo. Two (Victoria and Elizabeth) will head west to Farringdon, while the third will head east to Victoria Dock portal. It will then be dismantled and brought back to Limmo to construct the second tunnel to Victoria Dock. Another TBM will set out from Pudding Mill Lane and tunnel to the Stepney Green crossover cavern. There it will be dismantled and removed via the shaft, to return to Pudding Mill Lane to bore the second tunnel. The last two TBMs (Mary and Sophia) will set off from Plumstead and tunnel to North Woolwich. ▶

All photos in this feature © Crossrail

The Crossrail Project is the biggest tunnelling project under London in a century

Most of the underground structures are due to be completed by 2015, when systems fit out will begin.

The route runs the gamut of London geology. Royal Oak Portal is constructed in the London Clay. The tunnels continue in the London Clay through Bond Street and Tottenham Court Road stations until Fisher Street Crossover, where the Soho anticline brings Palaeocene strata closer to surface and the tunnels enter Lambeth Group clays and sands.

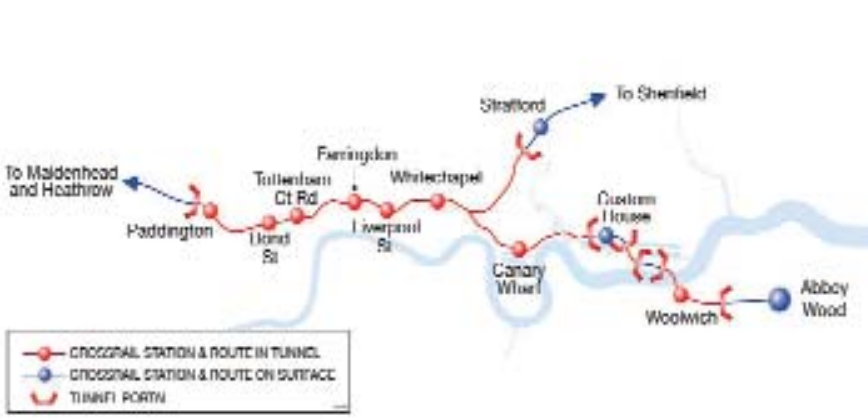
Between Fisher Street, Stepney Green and Pudding Mill Lane, the tunnels mostly follow the boundary between the London Clay Formation and the Lambeth Group. South east of Stepney Green the tunnels descend through the Palaeocene sequence in to the Thanet Sand Formation as they cross the Millwall anticline - centred at Canary Wharf - before rising up to terminate in the London Clay at Victoria Dock portal. The portal lies on the eastern side of the Greenwich Syncline and recently discovered Plaistow graben. The route continues east through Silvertown, along the surface section that was the former North London Line and over the Greenwich Fault Zone.

North Woolwich portal is constructed through Alluvium overlying River Terrace Deposits and into the Chalk, which is here brought to surface by the Greenwich Anticline. The tunnel then continues mostly through Chalk to Plumstead portal, only rising into the Thanet Sand Formation at Woolwich Station.

The geology partly controls construction methodology, with the Sprayed Concrete Lining (SCL) methods being used in London Clay and Lambeth Group clays at station tunnels, shafts and cross passages. Bolted segment linings are to be used in cross passages in the Thanet Sand and the Chalk. Paddington and Woolwich box Stations are of 'diaphragm wall' construction - a reinforced concrete wall constructed in the ground by excavating a narrow trench that is kept full of bentonite slurry. However, Canary Wharf box station has been constructed with piled walls. This is because Canary Wharf sits in the middle of West India Dock, and three of the station walls are also the edges of a cofferdam and tie into existing retaining walls.

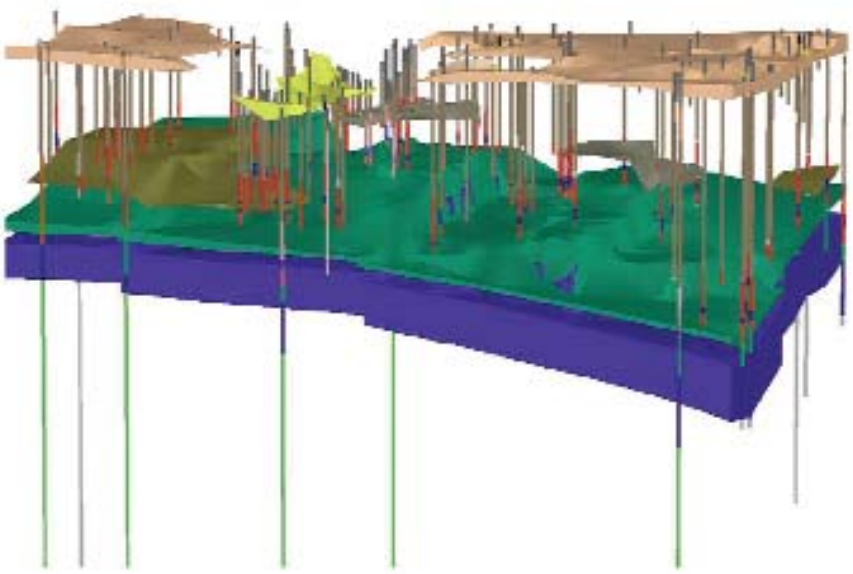
ACT OF PARLIAMENT

The scheme, which is financed by a mixture of private and public funding and required an Act of Parliament, was



Overview of the Crossrail route

Ready for the Tunnel Boring Machine – the Royal Oak portal, west of Paddington awaits the arrival of 'Phyllis'



A three dimensional block model as supplied by the British Geological Survey, showing boreholes and formations of interest

A typical selenite crystal

TABLE 1

Period	Series	Group	Formation	Member or Deposit
Quaternary	Holocene			Alluvium and Made Ground
	Peistocene			River Terrace Deposits
Palaeogene	Eocene	Thames Group	London Clay	
			Harwich Formation	Swanscombe, Oldhaven, Blackheath
	Palaeocene	Lambeth Group	Woolwich Formation Reading Formation Upnor Formation	
Cretaceous	Upper Cretaceous	Chalk Group	Seaford Chalk Formation	

Table showing the stratigraphical relationships of the geological units referred to in the text

Crossrail includes five permanent shafts for ventilation, maintenance and emergency access

Core drilled through a geological fault, showing the fault plane

Cubes of iron pyrites

first proposed and began its passage through Parliament between 1989 and 1996. The project was restarted in 2002 and extended to its current alignment. Over the last 10 years, 37 packages of ground investigation were carried out over the entire tunnelled route to form a geological model, obtain samples for derivation of engineering parameters and form a baseline of groundwater monitoring, including tidal monitoring. Ground investigations, comprising 1043 boreholes with a total length of 34,341m, were completed in 2011. Third party data sources were accessed adding 653 boreholes (25,156m). The Crossrail ground model is built around almost 1700 boreholes representing c. 60km of ground and the database combining all ground investigation data contains well over a million lines of data and can be accessed easily and quickly.

The depths involved meant that ground investigations had to be based around deep boreholes, typically between 40m and 60m deep - although the deepest reached 114m. All boreholes were drilled off the tunnel route, to avoid forming pathways for water, and so that grouted boreholes could neither provide a flow-pathway nor collapse when encountered at depth - a particular risk in SCL sections. Deep boreholes carry risks, especially from jammed casing. In recent years all boreholes deeper than 30m were rotary cored to minimise these risks and improve safety for drilling teams. In addition to providing utilities drawings, specialist surveys were carried out to mark out utilities on the ground prior to drilling and flame retardant coveralls were mandated during inspection pit excavation.

Crossrail was careful to ensure a consistent approach to variations in stratigraphy along the route, identifying fault zones through detailed geological logging, as well as areas that were especially hard (nodules, concretions) or soft. We ran training courses for contractor staff, using geologists expert on the groups to be encountered. Particularly difficult sections with contemporaneous faulting were check-logged by the specialists themselves and confirmed numerous faults along the route. For the running tunnels, boreholes were drilled on average 100-150m apart depending upon obstructions and geological variation. Relatively homogeneous deposits such as the London Clay were investigated at a slightly wider spacing whereas the more variable Lambeth Group was ▶

investigated at slightly closer spacing. Although the ideal spacing had to take account of local obstructions. Boreholes were drilled wherever a rig could be squeezed including car parks, parks, basements and tiny yards. Many times suitably sized areas were identified only to find that all the utility companies had got there first!

Crossrail is a major project beneath a historic and congested urban area. It was important that risks associated with ground conditions were identified, understood and managed throughout the design and construction stages of the project. The risks to the project come in two forms - stratigraphic risks arising from the geology and location risks due simply to working in London. Two main stratigraphic risks arise from obstructions and irregular groundwater flows. Several strata contained irregularly cemented horizons, nodules and concretions. Advanced knowledge of these is important for TBM design and for constructing excavations. The face of the TBM contains teeth and cutters that tend to get broken and worn by nodules and concretions, which tend to be much stronger than the surrounding matrix. This slows down progress.

The London Clay contains layers of septarian nodules, typically up to 150mm thick and up to 2m across. The Harwich Formation contains irregularly developed concretions. One, encountered in the Isle of Dogs (Blackheath Member), measured a metre in thickness and five metres by ten metres in plan - a significant obstruction. In a large excavation, it poses few problems as heavy machinery can be brought in. However in a small or deep excavation the situation is completely different and can lead to damaged equipment or very slow progress. The Lambeth Group presents another form of obstruction, namely water flows from sand channels. During the Palaeocene, these were channels - small streams to large rivers - crossing the tidal mudflats between mangrove swamps, especially in the east, where the environment was becoming shallow marine. Their sinuosity and variability make them very difficult to predict and locate. Trying to drill through one is like finding a needle in a haystack. These rapid lithological changes make resolving fault alignment even more difficult and this is where detailed logging to the latest stratigraphic nomenclature comes into its own.

We installed 1132 piezometers to provide detailed information on the pore pressure profile along the entire tunnelled route. Particular attention has been paid to monitoring groundwater in the sand channels. These are in continuity with the clays surrounding them, but the difference in permeability means that water influx can affect the stability of excavations. Again, this is more a problem for SCL construction than when using a closed face TBM. Pump testing has helped us design depressurisation systems for in-tunnel dewatering. Groundwater monitoring has been on going in a co-ordinated programme since the 1990s and restarted during the early 2000s. This growing dataset has been used to derive groundwater pressures on the structures before and during construction. Wider groundwater monitoring by the Environment Agency has been used in modelling for the 120-year design life of Crossrail structures.

The risks of simply being in London include faulting, obstructions and the

Tunnel boring machine 'Phyllis'

Tunnelling began in May 2012 from Royal Oak portal, with two TBMs (Phyllis and Ada) tunnelling towards the eastern end of Farringdon Station

A concretion in the Harwich Formation

Crossrail will utilise some pre-existing tunnels

TBM in position and beginning its run

presence of sensitive structures. Knowledge of faulting in London is changing with the ground investigations from large projects like Crossrail. In the 1990s when the route for Crossrail was first being planned, it only appeared to cross one major faulted area (Northern Boundary Fault). Crossrail has since worked with BGS to produce a three-dimensional block model for Farringdon Station which indicated three main sets of faults with varying degrees of uncertainty. Additional phases of ground investigation have not only targeted and reduced these areas but also indicated additional faults in each set.

The detailed logging of borehole samples and cores has helped to define faults across the entire route. For example, an additional eight faults have been discovered in the Chalk alone! The recently discovered Plaistow Graben has now been extended south west to cross the Crossrail route near Isle of Dogs. Knowing where faults lie is important for two reasons. First, ground conditions can change across a fault. This is particularly important for SCL construction, as changes from clay to sand, especially water bearing sand, can affect excavation stability, the potential for base heave and dewatering requirements.

Second, faulting rarely occurs as a single plane; more usually it is a series of fractures that breaks up the ground and creates voids, resulting in an increase in secondary permeability, decreased excavation stability and greater transmission of ground movements. The fault zone can form a preferential path for groundwater flow along it or form a barrier to water flow across it. These flows can have a significant influence on the development and performance of dewatering schemes, potentially leading to differential settlement across fault zones or additional dewatering requirements. Also, the broken ground contains sheared blocks that can fall into excavations. Not only does this cause over-break, but it is a potential safety hazard for the workforce. It has been a feature of excavations in London Clay with miners traditionally referring to the blocks as 'greasy backs'.

London has a long history which records much of our technological development. Hydraulic and pneumatic power networks for lift rams, wells and all kinds of deep foundations remain in the ground even when the original aboveground structure have long gone. A team of people have scoured numerous public and private archives to collect the available information, confirm the nature of any clashes and provide any mitigation measures. Records of these obstructions can vary from detailed to non existent, including duplicated and erroneous data. Safeguarding procedures through council planning applications reduces the risk of clashes with very recent developments.

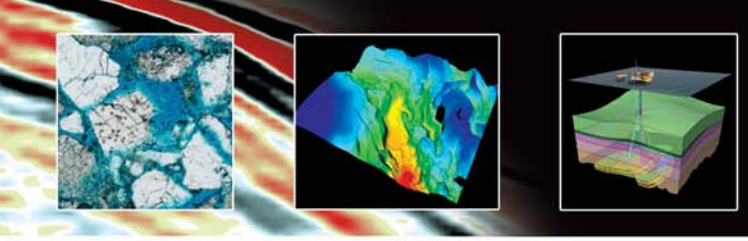
GROUND MOVEMENT

Tunnelling causes ground movement at the surface because the face of the TBM is slightly bigger than both the shield behind it and the segmented tunnel lining constructed behind that. Ideally, the ground pressures are balanced across the face of the TBM so that the face does not relax or move significantly. The space behind the face and around the shield is filled with grout as soon as the segments are placed, but the ground does move a small amount, typically around 1.5% of the area of the TBM face. The movement is transmitted to the surface and, typically, results in a broad and shallow settlement trough – c. 30m across and c. 25mm deep at the centre.

The Crossrail route crosses under some 474 listed buildings, of which eight are Grade 1, myriad utilities including major sewers and much of London's transport infrastructure (Underground, roads and canals). Settlement assessments have been carried out on each, within the settlement trough, to determine the movements that could arise, using industry-recognised procedures and software. Buildings and all infrastructure are instrumented, subject to a co-ordinated monitoring regime, and mitigation measures implemented where necessary. Detailed knowledge of ground conditions feeds directly into the settlement assessments, as the movements are calculated to be small but also because many of the structures assessed are fragile.

The Crossrail project has involved a huge effort, just to get to construction - involving ground investigation and baseline monitoring over many years. Improved understanding of the ground model has benefited the project's ability to calculate ground movements, plan mitigation measures and has contributed enormously to our understanding of London's geology. ■

* **Ursula Lawrence** EurGeol Ursula Lawrence CGeol CSci FGS is an engineering geologist working for Crossrail. She is a registered Chartership mentor and scrutineer



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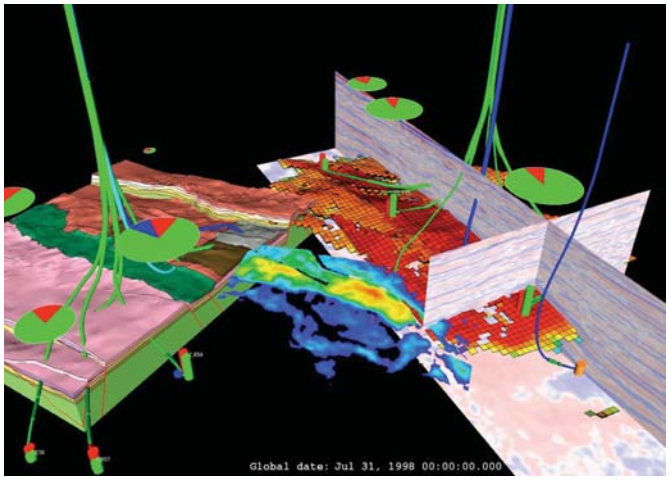

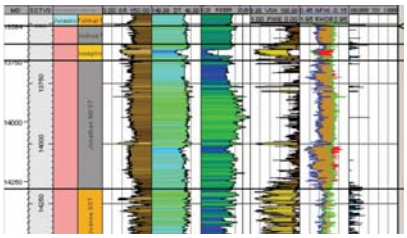

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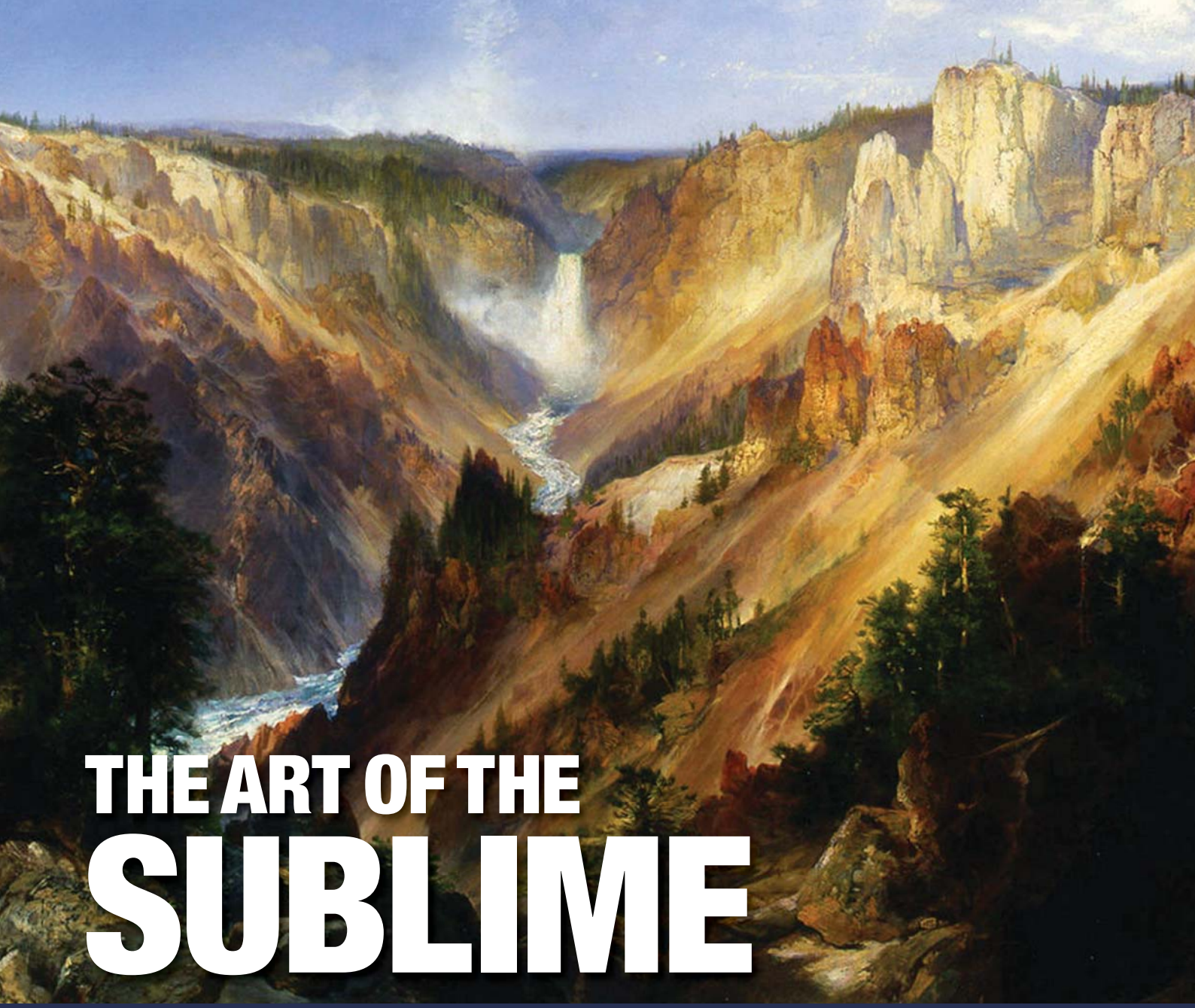


THE ART OF THE SUBLIME

Dr Alexis Drahos, art historian, on the last and most geological of American 19th Century landscape painters

Thomas Moran (1837-1926) is regarded as one of the most famous American landscape painters of the second half of the 19th Century. To understand his work, we must consider the beginnings of the Hudson River School, which developed in the early 1820s in the emerging American nation. This pictorial movement devoted itself basically to landscape painting and, above all, 'virgin Nature' as exemplified by the landscape of the West.

It was not rare for painters who were part of this movement to be keen scientists - and specifically, amateur geologists. Thomas Cole (1801-48), the first painter of this school, who achieved celebrity as early as the 1820s, owned a mineral collection and his paintings are thoroughly imbued with geology. As for Frederic Edwin Church (1826-1900), he followed in the footsteps of German naturalist Alexander Von Humboldt – who travelled in South America between 1799 and 1805 and depicted Chimborazo. Like his two predecessors, Thomas Moran was an Earth science enthusiast and brought this interest to the fore in his canvases.

Above: Extract from *The Grand Canyon of the Yellowstone* (1893-1901) Thomas Moran Born: Bolton, England 1837. Died: Santa Barbara, California 1926. Oil on canvas. Smithsonian American Art Museum, Gift of George D. Pratt 1928 (2nd Floor, North Lobby, if you're nearby)

POWELL

The Chasm of Colorado, one of his most famous works, was painted after Moran participated in John Wesley Powell's (1834-1902) geographical and topographical survey, in the summer of 1873. This was one of the four 'Great Surveys', funded by Federal Government during the early 1870s. Their main goal was to estimate the natural resources of the Western territories, putting great emphasis on the areas's geology and topography. The Surveys brought together scientists, artists and photographers.

Moran had already taken part in the Hayden Survey (1871), an experience that resulted in another famous canvas - *The Grand Canyon of the Yellowstone*. Under the influence of John Wesley Powell, Thomas Moran embraced the geological theories of Charles Lyell ▶

Image: Thomas Cole (Public domain), via Wikimedia Commons

***View from Mount Holyoke, Northampton, Massachusetts, after a Thunderstorm - The Oxbow*, 1836 Thomas Cole (1801–48) Oil on canvas**

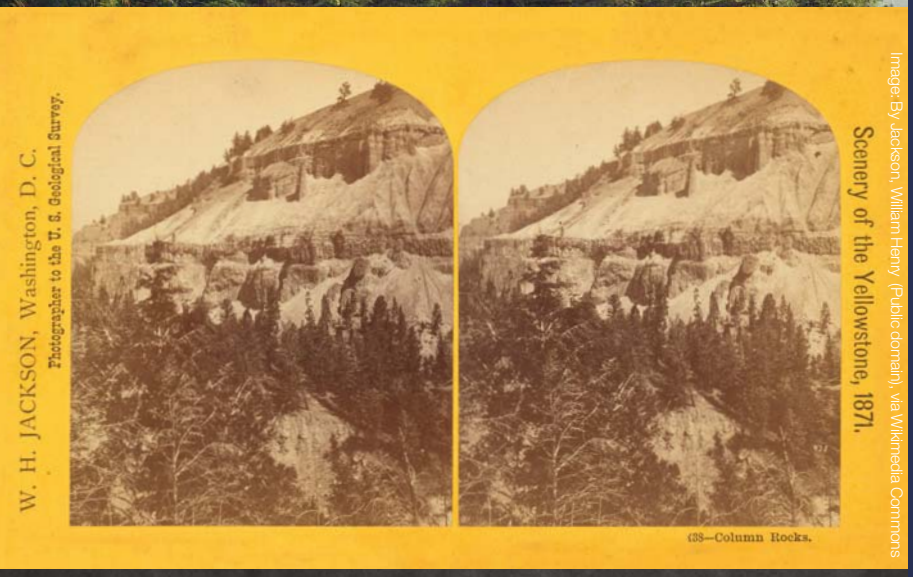


Image: By Jackson, William Henry (Public domain), via Wikimedia Commons

***Column rocks* from *Scenery of the Yellowstone, 1871* by William Henry Jackson. One of a series of stereoscopic pairs from the Hayden Geological Survey**

Thomas Moran (1837-1926)

who argued that our planet was constantly evolving, experiencing continuous cycles of erosion, deposition and uplift at an infinitely gradual pace. Such views were presaged by *Cosmos* (1845-47) the epochal book of Alexander Von Humboldt, whose American fame was reaching its zenith at this time.

The *Grand Canyon of the Yellowstone* brings Moran's interest in Earth-shaping processes to the fore. By this time, Moran had already seen photographs of the Grand Canyon from George Wheeler's recent expedition, and he clearly recognised that the western landscape would offer rich material for his pictorial gift. Contrary to *The Grand Canyon of the Yellowstone*, whose subject was fire, *The Chasm of Colorado* deals rather with the action of water. Some elements hint at the work of water - the pools in the foreground, and the low-lying clouds. Most impressive is the threatening thunderstorm, which dramatises the work of subaerial aqueous erosion.

The geologic province depicted is the Colorado Plateau, known for its well preserved, mainly sedimentary sequence of Palaeozoic and younger Mesozoic rocks. The rocks represent a range of depositional environments from deep water to marginal marine limestones and desert sandstones. The painting suggests that the processes responsible for the chasm cut through them were more gradual than catastrophic. Moreover, the downcutting channels clearly meander, winding around in large curving patterns and suggesting slower development. This picture is all about erosion, and its almost timeless work over millions of years.

In Moran's time, it was generally accepted that our planet was much older than Biblical scholars claimed. As early as the mid 18th Century, geological prophets like James Hutton had already contemplated an Earth millions of years old. In this picture, the painter seeks to show us the transitory nature of the 'timeless' scene, and emphasises the changes continually wrought by natural processes. We can see this represented in the moving storm clouds and the balanced boulders in the right foreground.

DANTE'S INFERNO

There is no sign of life anywhere, and no human interest. Contemporary commentators likened this painting to a extra-terrestrial landscape. Many of Moran's contemporaries saw also Dante's inferno in *Chasm of the Colorado*, while others saw a geologic textbook in which the chief protagonist was water. After his first visit in 1873, Moran returned to the Grand Canyon many times. He depicts here a world of desolation.

While on location, Moran wrote to his wife Mary : "*The whole gorge for miles lay beneath us and it was by far the most awfully grand and impressive scene I have ever yet seen. The color of the Grand Canon itself is red, a light Indian Red, and the material sandstone and red marble and is in terraces all the way down. All above the canyon is variously colored sandstone mainly a light flesh or cream color and worn into very fine forms*".

To Moran, unless a geologist could look at his painting and judge its geological accuracy, he could not be confident in his work. By the virtue of his interest in Earth science, Thomas Moran follows the example of a number of painters before him, such as William Turner, an artist he greatly revered. Moran seems to have been introduced to Turner through Ruskin's *Modern Painters* (1843-60). Moran was also profoundly influenced by John Ruskin and until his death in 1926, would claim that landscape painting must be rooted in a profound knowledge of nature.

Right: *The Chasm of Colorado* 1873-74) by Thomas Moran. Oil on canvas mounted on aluminium. Smithsonian American Art Museum, lent by the Department of the Interior Museum (and hung on the 2nd Floor, North Lobby)

In this picture, depicting the geological history of the region, Thomas Moran created a *tour de force*. He shows, with the accurate depiction of the site and specifically the rocks and the strata, that he kept abreast of the progress of the science of his time. However, this painting was not his last geological picture - witness *The Mountain of the Holy Cross* (1875) where the painter addresses the question of glacial deposits. This painting, coming after *The Grand Canyon of Yellowstone* and *The Chasm of Colorado*, completes the trilogy. The glacial geology of the Holy Cross Valley was studied by Ferdinand Hayden in his book *The Yellowstone National Park, and the Mountain Region of Portion of Idaho, Nevada, Colorado, and Utah* (1876). In this painting, Thomas Moran depicts accurately for example the *roches moutonnées*, which one can observe prominently in the middle distance.

In his letters, Thomas Moran shows that he was conversant with geological vocabulary when he writes: "*The descent into the valley was even steeper than the ascent had been but was freer from fallen timber. We got down all right and without accident, but Horror ! the way up the valley was infinitely worse than anything we had yet encountered. A swamp covered with the worst of fallen logs and projecting through which were the Roche Moutonnées or Sheep Rocks, rounded and smooth, slippery, varying from 10 to 40 feet high*".

The representation of a cross on the summit in the background could hint at relations between science and religion, at a time where the two could still be linked. A number of scientists of the time - and artists interested in geology- believed in God and did not regard science and religion as being at all incompatible.

Thomas Moran was unquestionably the last great American painter of the 19th Century to espouse a profound interest in geology. His vast landscapes are imbued with Earth science, just like those of his forerunners Thomas Cole and Edwin Church. While continuing a great tradition into the final years of the 19th Century, he also brought about its closure. ■

READERS' LETTERS

Geoscientist welcomes readers' letters. These are published as promptly as possible in *Geoscientist Online* and a selection printed each month. Please submit your letter (300 words or fewer, by email only please) to **ted.nield@geolsoc.org.uk**. Letters will be edited. For references cited in these letters, please see the full versions at **www.geolsoc.org.uk/letters**

UK OLYMPIC NO-SHOW EXPLAINED

Sir, I was fascinated to read Dwain Eldred extolling the virtues of the IESO annual Earth Science Competition for secondary science students (*Geoscientist* 22.04 May 2012). The lack of a UK team at this event is a great shame, but is the result of three fundamental contributory factors.

First, the syllabus for the IESO has its roots in SE Asia where Earth science education is taken seriously and geology, geophysics, meteorology, oceanography, astronomy, and environmental science are taught as a coherent unit. Unfortunately Earth science is taught as an addendum in many UK schools and even this cursory coverage is at risk.

Second, to enter a viable team requires that a national competition identify the very best students before the UK could compete on an even footing. This would need organisational support from the Geological Society - the Institute of Physics, Royal Society of Chemistry and Institute of

Biology oversee team-selection for other 'science Olympiads'.

Finally, the small matter of funding a UK team's participation would need resolving. Unlike our athletic colleagues competing in London this summer, alas our outstanding UK Earth Science students will not have the opportunity to be Olympians for some time to come.

Kevin Stephen

MICROPALAEO WOE

Sir, The self-promotion of micropalaeontology has figured large in *Geoscientist* of late. I agree that it is a disappearing core discipline and that it has important applications. But no one seems to ask why it is losing its significance. Unlike other disciplines, which are becoming more important especially in the petroleum industry, biostratigraphy has failed to enter the 21st Century. I strongly believe it needs to reinvent itself and free itself from the past. With so many passionate thinkers out there, I am sure this approach should not be a problem. But at the moment all that is discussed is "saving" the old ways. That is not the best for this essential discipline. At wellsite, for example, 21st Century technologies are being more widely used than ever before.

By ignoring its shortcomings for long time, this discipline will further lose importance and appeal. There are sadly very few pioneers left and these are usually heavily criticised. So, I plead to micropalaeontologists. Stop patting each other on the back, stop thinking it is a perfect discipline and start reinventing yourselves – geology needs you!

Cornelia Kohler

Sir, I would like to endorse the article on the near demise of micropalaeontologists (*Geoscientist*, 22.4, May 2012). It is certainly the case that the number of micropalaeontologists has diminished over recent years, with retirements and the lack of training for the young.

The problem was foreseen and discussed in the 1990s, in various informal groups and within NERC reviews, but without any strategic plan forthcoming. The fault lies with the academic funding bodies and industry, who both failed to realise the importance of the science *per se* and its application to the discovery and recovery of hydrocarbons and the associated generation of wealth. Recently the use of micropalaeontology has become an important tool in documenting climate change with major implications for the future well being of our planet.

There is a need to ensure a continuity of university training to maintain micropalaeontology as a healthy part of the Earth science curriculum. With the demise of certain 'centres of excellence' we need to provide new generations with the skills that will be in demand to solve problems within hydrocarbon exploration, resource management and global climate change. Centres of excellence usually grow around a core of talented personnel who can provide basic training and also inspire innovative research. Such people need to be identified and nurtured while still young, so that the rest will follow.

Rex Harland

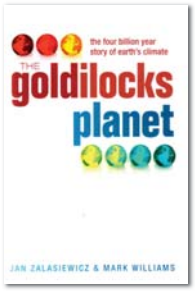
WORTH A WAGER

Sir, I was very surprised to read in *Everest - the best writing and pictures of seventy years of human endeavour* (Edited by Peter Gilman, Foreword by Sir Edmund Hillary), that three climbers reached an altitutude of 28,100ft (8565m) on Everest in 1933 ('*My Nastiest moment*', Jack Longford, pp.42-46).

I did my Part II in Chemistry at Oxford in 1966 in the Department of Geology at Oxford University, under the supervision of Dr Norman Snelling, where Lawrence Wager was Professor. As I understood it, Wager made a solo climb on Everest to 28,100ft in 1933 but was obliged to descend after facing a large slab of rock about two metres high with a very smooth surface and no suitable handgrips - which he considered un-climbable. He used his remaining time at this extreme altitude to collect geological samples, which were later stored at the Geological Museum in Oxford and ignored until the early 1950s when they were found and studied in detail. The claim that Jack Longland was also at 28,100ft on Everest during this expedition therefore seems to be mistaken.

Geoff Glasby

Everest – Lawrence Wager made a solo climb to 28,100ft in 1933 but was forced back



Goldilocks Planet

Astronomers call 'Goldilocks Planets' the ones that are 'just right' for life. Distance from the Sun is not the only control. James Lovelock suggested that life adapted Earth's environment to suit itself. So despite our having a sun that, like others of its kind, started out faint and grew strong, life conspired to keep our climate equable. Indeed, life changed our atmosphere radically as it evolved from single-celled oceanic creatures to land plants, dinosaurs, and us, introducing oxygen along the way. Asteroids played a role early on, but impacts by large bolides have been rare in the past 500 million years. Even so, they may have changed our atmosphere enough to cause mass extinctions, like that between the Cretaceous and Cenozoic Eras; though the jury is still out and massive eruptions of plateau basalts may have played as important a role.

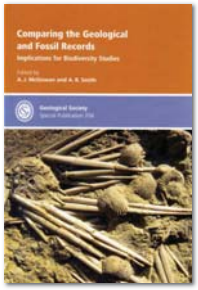
A blanket of water vapour along with a little methane and CO_2 kept Earth's environment warm by absorbing infrared radiation emitted from the surface. Although three gases make up less than 2% of the atmosphere, they cause much of the warming we experience, so quite small changes have a disproportionately large effect. On geological timescales atmospheric CO_2 increases when seafloor spreading is widespread and volcanoes active, and decreases with chemical erosion during mountain building.

The rise of land plants in and after the Devonian complicated matters. Plants feed on CO_2 and release it to the atmosphere when they decompose, unless trapped as peat or coal. Controls on CO_2 are complicated by whether sea level is low or high. Wobbles in the Earth's orbit and axis modulate solar radiation on timescales of 20, 40 and 100 thousand years. These interacting controls led to periods when the CO_2 in the atmosphere dropped to almost zero and ice became widespread, interleaved with periods where CO_2 was abundant and ice was limited or disappeared.

Our climate's trajectory through time is written in the rocks. When we see in that record evidence for conditions that have no modern analogue we can argue that repeating those conditions may bring similar results. Based on that record, the authors conclude we are now entering the Anthropocene - a period marked by human activity, where further additions of carbon dioxide to the atmosphere may create a climate of little ice and high sea level not seen since the warm periods of the Pliocene or the Eocene. This is a stirring tale, well told; a 'message in a bottle'. Will we pay attention?

Reviewed by ***Colin Summerhayes***

THE GOLDILOCKS PLANET – THE FOUR BILLION YEAR STORY OF EARTH'S CLIMATE
JAN ZALASIEWICZ & MARK WILLIAMS, Published by Oxford Univ. Press. ISBN 978-0-19-959357-6. 303 pp
List price £16.99



Comparing Geological and Fossil Records

This book is made up of a collection of different papers tackling the problem of extracting reliable information on biodiversity change from an imperfect geological record. The papers are an eclectic mix, ranging from information-theoretical approaches to in-depth studies, looking in detail at how studies of the fossil records of particular organisms can be applied.

The book begins with an excellent introduction by the editors. There follows a varied mixture of studies in which invertebrates (including microfossils) and vertebrates receive equal attention. The book also boasts wide coverage in time, including material from the whole Phanerozoic.

It is pleasing that a number of supplementary materials have been made available on the Internet, allowing readers to explore topics in more detail. This should be commended also for keeping the cost down! A number of graphs and charts are included with the papers, and these have reproduced very clearly. The use of colour is particularly gratifying in this context, for colour does help considerably with interpretation. However, one does wish that figure 4 on page 148, which should have been reproduced in colour, had indeed been – as this would have made it much easier to use.

The book is an invaluable contribution to this area of study. With the mixture of papers presented it allows a comparison of many different methods and gives a suitable starting point for wider in-depth studies.

The book has a wide potential readership, and I would recommend it to anyone interested in the Earth or life sciences. In an ideal world it would be made available to undergraduates studying any aspects of palaeobiology. It should definitely be found on the bookshelves of all university geoscience departments, as the wide ranging discussion afforded allows for a high degree of integration while also providing a comprehensive 'snapshot' of our knowledge and opinions on this complex subject at the present point in time. This book would also be invaluable for developing extension work for students studying 'A' level Geology, as the papers are not only clearly set out but readily accessible. Highly recommended.

Reviewed by ***Gordon Neighbour***

COMPARING THE GEOLOGICAL AND FOSSIL RECORDS – IMPLICATIONS FOR BIODIVERSITY STUDIES
A J MCGOWAN AND A B SMITH (eds), ISBN: 978–1–86239–336-3 Geological Society Special Publication 358
RRP: £90.00 Fellows' price: £45.00

REVIEWS: COPIES AVAILABLE

We have received the following books. Please contact ted.nield@geolsoc.org.uk if you would like to supply a review. You will be invited to keep the review copy. See Geoscientist Online for an up-to-date version of this list.

- **Lake District Mountain Landforms,** Wilson, P (2011)
- **Modelling Uncertainty in the Earth Sciences,** Caers, J (2011)
- **Structural Geology Algorithms: Vectors and Tensors,** Allmendinger, RW, Cardozo, N & Fisher, DM (2011)
- **Spatiotemporal Data Analysis** Eshel, G (2012)
- **Understanding Earth's Deep Past: Lessons for our climate future** (2011)
- **An Introduction to Geological Structures & Maps** (8th Edn) by George M Bennison, Paul A Olver, Keith A
- **Continuum Mechanics in the Earth Sciences** by William Newman

PEOPLE

Geoscientists in the news and on the move in the UK, Europe and worldwide

The Apprentice(s)

Students and early career geologists gathered at Burlington House on 25 April for the final of our first National Schools Geology Competition and Early Career Geologist Award. **Sarah Day** reports.

Photos: Ted Nield

Schools competition winning team from South Wiltshire Grammar and Bishop Wordsworth, Salisbury, receive their trophy from Bryan Lovell, President

Davide Gamboa (Cardiff University, Southern Wales Regional Group) takes the Early Career Award

Students, drawn from schools across the UK, gave presentations arguing their case for the most inspirational geological site in the UK, their chosen sites ranging from Worm's Head, Rhosili in Gower to the Cornubian batholith in Cornwall. They then took part in a quick-fire quiz, presided over by GSL Vice President Paul Maliphant.

The four finalists in the Early Career Geologist Award each gave a 20-minute presentation detailing the work they have been doing in their careers so far. The judges selected Davide Gamboa, finalist from the Southern Wales Regional Group, as overall winner. Davide's PhD, from Cardiff University, takes a 3D-seismic approach to the problem of reservoir compartmentalisation on continental margin settings.

VALLIS VALE

The Schools competition was won by South Wiltshire Grammar and Bishop Wordsworth, Salisbury, who chose the De la Beche Unconformity in Vallis Vale as their inspirational site. The Society extends its congratulations to everyone who took part, but especially to Davide and the winning schools.

HELP YOUR OBITUARIST

The Society operates a scheme for Fellows to deposit biographical material. The object is to assist obituarists by providing contacts, dates and other information, and thus ensure that Fellows' lives are accorded appropriate and accurate commemoration. Please send your CV and a photograph to Ted Nield at the Society.

CAROUSEL

All fellows of the Society are entitled to entires in this column. Please email ted.nield@geolsoc.org.uk, quoting your Fellowship number.

CHRIS HAWKESWORTH

Chris Hawkesworth, Deputy Principal & Vice Principal of Research, University of St Andrews, as well as winning the Wollaston Medal this year has also been elected Fellow of the Royal Society of Edinburgh. Chris was one of 46 new UK and International Fellows added to its 1500-strong Fellowship this year.

IN MEMORIAM WWW.GEOLSOC.ORG.UK/OBITUARIES

THE SOCIETY NOTES WITH SADNESS THE PASSING OF:

Chappel, Bruce *
Guest, John
Hooper, Peter L *
King, Bruce *
Middleton, John *
MacLean, Ronald G *
Williams, Colin L *

In the interests of recording its Fellows' work for posterity, the Society publishes obituaries online, and in *Geoscientist*. The most recent additions to the list are shown in bold. Fellows for whom no obituarist has yet been commissioned are marked with an asterisk (*). The symbol § indicates that biographical material has been lodged with the Society.

If you would like to contribute an obituary, please email **ted.nield@geolsoc.org.uk** to be commissioned. You can read the guidance for authors at **www.geolsoc.org.uk/obituaries**. To save yourself unnecessary work, please do not write anything until you have received a commissioning letter.

Deceased Fellows for whom no obituary is forthcoming have their names and dates recorded in a Roll of Honour at **www.geolsoc.org.uk/obituaries**.

DISTANT THUNDER

'Twas ever thus

As geologist and science writer Nina Morgan discovers, it's never been easy to pin down a scientist

It's a common complaint from listeners to news programmes such as Radio Four's *Today*. No matter how hard the interviewer tries, scientists being interviewed almost always hedge their answers with a plethora of caveats. In short, they are generally reluctant to state any finding as a firm conclusion.

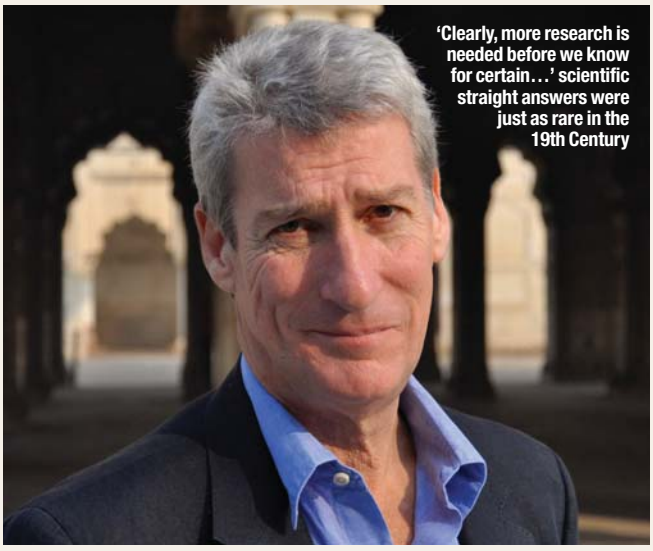
If it's any consolation to the Jeremy Paxmans of this world, their predecessors in the 19th Century suffered the same difficulties. And, then as now, scientists were often reluctant to give straight answers, even when speaking to their peers. A letter about The Pilsen Permo-Carboniferous Beds published in the *Geological Magazine* in March 1877, illustrates the case:

"Sir, -- In the extremely interesting paper on the Permo-Carboniferous beds of Bohemia which appears in the current number of the *Geological Magazine*, Dr O Feistmantel appears to rely very strongly on the announcement which he says was made by Dr Anton Fritsch at the last meeting of the British Association that he considered the Nürschan Gas-coal horizon as a passage-bed from Carboniferous to Permian. Now when Dr Fritsch exhibited his splendid series of specimens before the Geological Section, it was evident that he avoided carefully expressing any statement of opinion as to the exact age of the beds whence they came.

A member then rose and asked Dr Fritsch whether he considered the Pilsen Gas-coal series as Carboniferous or Permian, or whether he looked upon them as passage-beds. The only answer elicited from the cautions palaeontologist was that it was not yet time to settle the matter, and that more work was required before the question was ripe for decision. In fact, he declined to give any clue as to what his views on the subject might be.

8 March 1877 [signed] The Questioner Himself"

Sound familiar?



'Clearly, more research is needed before we know for certain…' scientific straight answers were just as rare in the 19th Century

ACKNOWLEDGEMENT
The source for this vignette is a letter titled The Pilsen Permo-Carboniferous Beds, which was published in the *Geological Magazine*, Decade 2, vol. 4, p.191

If the past is the key to your present interests, why not join the History of Geology Group (HOGG)? For more information and to read the latest HOGG newsletter, visit: **www.geolsoc.org.uk/hogg**, where the programme and abstracts from the Conference on Geological Collectors and Collecting are available as a pdf file free to download

***Nina Morgan** is a geologist and science writer based near Oxford

OBITUARY

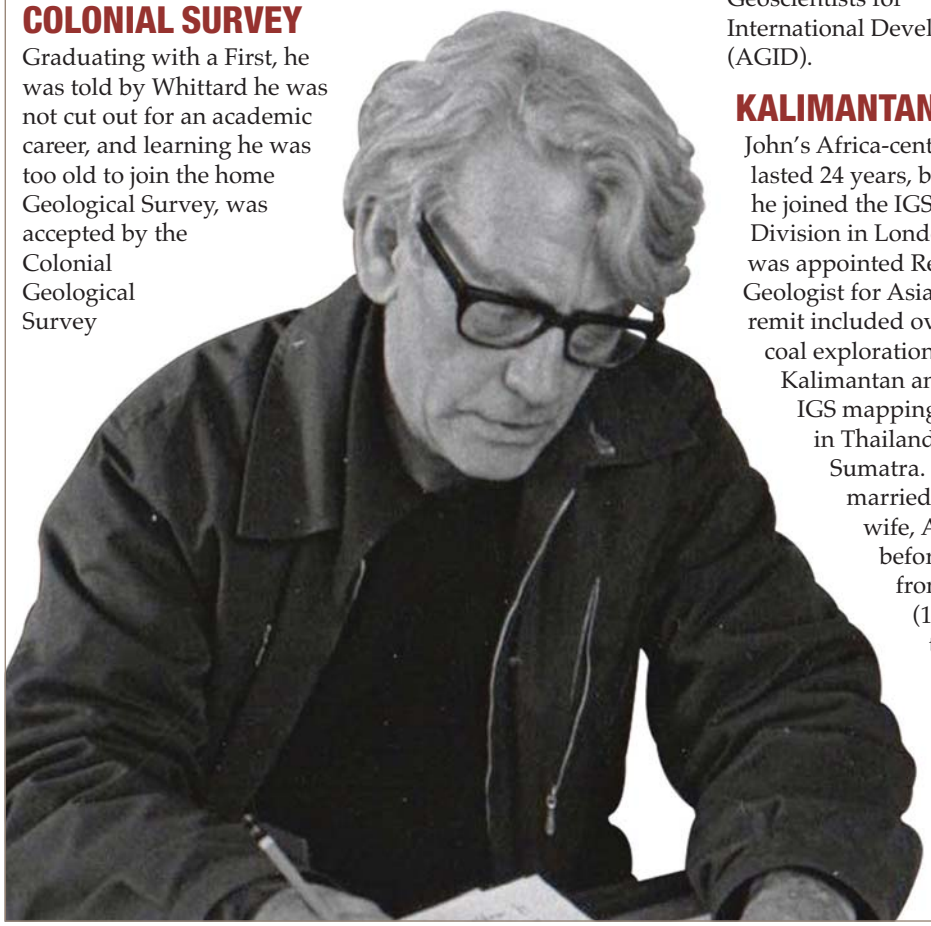
JOHN VORD HEPWORTH 1919-2012

Geologist who began his career in the Colonial Geological Survey and spent much of his life in Africa

John Hepworth died aged 92 on 15 January in hospital near his Stevenage home. He was born in Southport on 29 November 1919 and, influenced by his father, developed a love of natural history and the outdoors. Army service (1939-45) through the war 'achieved very little' and on demobilisation he accepted a place to read geology at Bristol under Walter Whittard, with Frank Coles Phillips a powerful influence.

COLONIAL SURVEY

Graduating with a First, he was told by Whittard he was not cut out for an academic career, and learning he was too old to join the home Geological Survey, was accepted by the Colonial Geological Survey and in 1951 was assigned to Uganda. His left-wing reputation at Bristol caught up with him during his probationary period and he was advised his position would not be confirmed. But with the support of his Director, an approach to the colonial Governor was successful and London's ruling was overturned. Field mapping and laboratory work were much to John's liking and from 1951-62 he authored reports and maps of widely different areas. During that period John spent a year at Leeds University under W Q Kennedy where he was awarded a PhD for a dissertation on the Western Rift of Uganda.



After a spell in the Photogeology Division in London, which saw him complete a study of the Mozambique Front in Tanzania (1969), John was appointed Director of the Botswana Geological Survey (1971-74), which fuelled his interest in older Precambrian terrains. Also, his interest in international development led him to becoming a founder member (1974) of the Association of Geoscientists for International Development (AGID).

KALIMANTAN

John's Africa-centred career lasted 24 years, but in 1975 he joined the IGS Overseas Division in London and was appointed Regional Geologist for Asia. His remit included overseeing coal exploration in Kalimantan and major IGS mapping projects in Thailand and Sumatra. In 1979 he married his third wife, Angela, before retiring from the IGS (1980) and taking up a position with the United Nations (ESCAP and RMRDC) in Bandung. In 1983 John retired and settled in Stevenage.

PUDDINGSTONE

A Fellow of the Geological Society since 1950, he served on Council and was Foreign Secretary from 1975-78. Also a keen member of the Geologists' Association since 1953, his research on the Hertfordshire Puddingstone was published in the *Proceedings of the Geologists Association* (PGA) in 1998. As well as his interest in Hertfordshire geology, he was active in seeking to protect the countryside north of Stevenage made famous by E M Forster. Other retirement pastimes included hill-walking trips with the Rucksack Club, and in later years a keen interest in art nouveau and the arts-and-crafts movement, which he would track down on 'safaris' to the Continent and to Rennie Mackintosh's Glasgow.

Toward the end of his life, when encouraged to write notes to help his obituarist, he would (with typical self-effacement) regret that he published so little during his lifetime. In fact, his bibliography has over 50 entries, many of them maps and government reports, but they include several published in the *QJGS*, the *PGA*, and *Nature*.

By **Michael Ridd**

CAN'T FIND YOUR MEETING? VISIT WWW.GEOLSOC.ORG.UK/LISTINGS FULL, ACCURATE, UP-TO-DATE

ENDORSED TRAINING/CPD

Course	Date	Venue and details
Introduction to Micromine	10-11 July	Challoner House, Clerkenwell, London. Introduction to Micromine (Day 1) and Introduction to Exploration (Day 2). 0930- 1730.
Cone Penetration Testing	28 September	Edinburgh. Free. Introductory course and technology update on Cone Penetration Testing theory and application. See website for other dates. Will also run on 14 December (Wallingford), 19 October (Nottingham), and 23 November (Exeter). **Contact:** Steve Poulter **E:** s.poulter@fes.co.uk **W:** www.fes.co.uk
Lapworth's Logs	n/a	'Lapworth's Logs' are a series of e-courses involving practical exercises of increasing complexity. 'Lapworth's Logs' provide training in applied geology for civil engineers, engineering geologists, environmental engineers, hydrogeologists, and anyone interested in ground modelling. **Contact:** info@lapworthslogs.com. Lapworth's Lgs is produced by Michael de Freitas and Andrew Thompson. Price dependent on number of users/duration of licence.

DIARY OF MEETINGS JULY 2012

Meeting	Date	Venue and details
Engineering Group Field Meeting: French Channel Coast Engineering Group	29 June-1 July	**Venue:** Dieppe and west (day 1) Antifer, Le Tilleul and Etretat (day 2), St Martin Plage, Criel and Le Tréport (day 3). **Leader:** Rory Mortimore. See website for details. **Contact:** David Giles **E:** dave.giles@port.ac.uk
Soft Ground Tunnelling Through London East Midlands Regional Engineering Group	7-8 July	Evening Meeting at BGS Keyworth. Speaker Ursula Lawrence (see Main Feature, this issue). **Contact:** David Boon **E:** dboon@bgs.ac.uk
Mendips Field Weekend South West Regional	7-8 July	A field weekend in the Mendips AONB led by Martin Whitely. **Contact:** Danielle Pullen **E:** swrg@geolsoc.org.uk
Field Meeting - Folkestone Warren South East Regional	7 July	Field visit to Folkestone Warren, Kent with Graham Birch, Network Rail. **Venue:** Folkestone Warren, Kent – see website for more details as they appear. **Contact:** John Ellis **E:** j.ellis133@btinternet.com
Water Resource Pressures on the Northern Limb of the Lower Greensand Solent Regional Group	18 July	**Venue:** NOC, Southampton. Evening meeting. **Speakers:** Jane Sladen and Steve Cox (URS) **Contact:** Karen Allso (Secretary) **E:** karen.allso@ramboll.co.uk

OBITUARY

GEOFFREY RUSSELL COOPE 1930-2011

Quaternary scientist whose work on beetles' genital armatures transformed our understanding of the Ice Age

With the death of Russell Coope geology loses an advocate of the unity of palaeontology and neontology. A lecturer seldom equalled, he was an original thinker, ready to question received paradigms about gradualism in evolution and climate change.

Graduating from Manchester in 1952, he completed a Master's on rugose corals before becoming geology demonstrator at Keele. Appointment to Birmingham by Fred Shotton extended his Quaternary interests. Russell was convinced that beetles in deposits at Upton Warren were worthy of study, taking the view that, matched with modern equivalents, they provided a means of reconstructing past environments.

DEVENSIAN

Overcoming suggestions that they must be contaminants, he matched like with like, finding warmth-loving insects where cold temperatures were thought to have prevailed. Not all were British species; it was 10 years before a mid-Devensian dung beetle was matched with specimens from Tibet. *Aphodius holdereri* proved to be one of many species to have shifted distribution radically, some eastwards to China, others southwards to the Mediterranean. It never occurred to Russell to describe a species as 'extinct' when so much was unknown.

His eye for detail was phenomenal. Russell met the comment that external morphology was insufficiently diagnostic and the genital armature was the only true arbiter of specificity by dissecting fossil abdomens and presenting genitalia. Publication of Chelford, where plant macrofossil, pollen and insect evidence were congruent, preceded Upton Warren, where disparity between beetles and pollen led to discord. The root of the problem was failure to understand differing rates of immigration among different taxa.

In the 1960s 'gradualism' prevailed, and departures were interpreted as faults in data. Russell's ability to match fossil with living communities should have despatched this argument, but only with the publication of Greenland ice-core data was it accepted that systems 'flipped' from one state to another. Russell summarised late glacial temperatures of middle England in a curve that rose rapidly to present day levels, then settled back to conditions similar to those of central Finland, plunged to the cold of the Younger Dryas, before finally warming rapidly into the Holocene.

He recognised the need for a numerical approach, converting each species' distribution into a climatic envelope, overlapping these to map a 'mutual climatic range' (MCR) – creating a curve remarkably similar to that which he had drawn intuitively! So original was he that even adversaries saw his contributions on insects an essential to any multidisciplinary study.

PRESTWICH

Retiring in 1993, he continued to complete work at many sites. His 220+ papers re-shaped our view of the Quaternary. Those who thought he cried wolf were won over by fossil insect evidence. When assemblages from the Early Pleistocene can be matched with modern ones, his point about instability promoting stability seems well founded.

A volume was produced in Russell's honour in 1997 and in 2005 he won the Society's Prestwich Medal. Birmingham University made him Honorary Professor of Quaternary Science, and Royal Holloway, Visiting Professor. He leaves his wife Beryl, a daughter and three sons.

By Paul Buckland

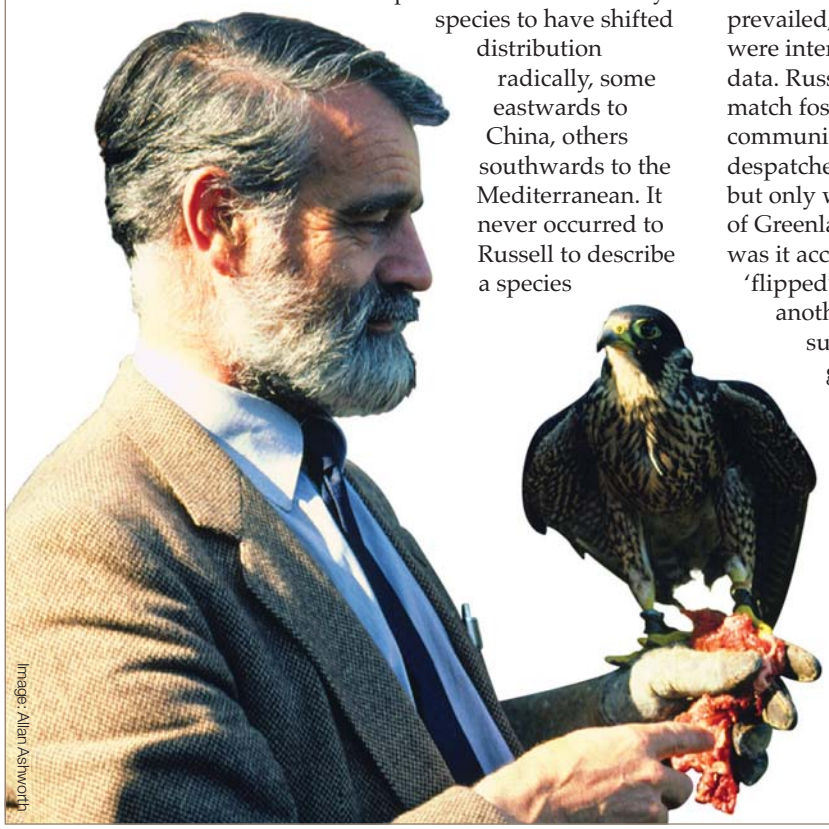
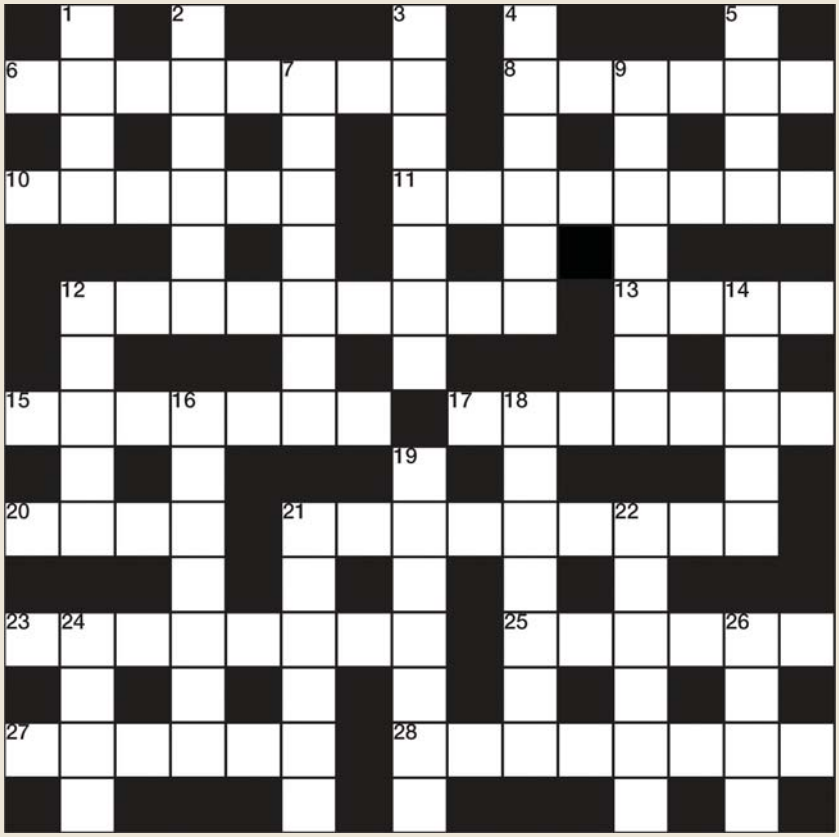


Image: Allan Ashworth

Left: Russell, with one of his ever changing menagerie of rescued animals, a falcon, one of which he trained to feature in *The Vikings*

CROSSWORD NO. 159 SET BY PLATYPUS



ACROSS

6 Emile, who invented a 1 down used in aligning the various optical components of a light microscope (8)

8 Facing stone with a smooth surface (6)

10 Stableman at a coaching inn (6)

11 Dark sediment rich in organic matter (8)

12 Krakatoa, Aberfan, 9/11 (9)

13 Freshwater body (4)

15 Heart contraction (7)

17 Still as in Cognac, not as in motionless (7)

20 Land surrounded on all sides by water (4)

21 Like the columns of the Giant's Causeway (9)

23 Philippine 20a, giving its name to the third deepest submarine trench (8)

25 Primary mould castings of any metal (6)

27 Vocalised form of communication in humans (6)

28 The 118 (so far) building blocks of the chemical world (8)

DOWN

1 Impersistent bed (4)

2 Worked areas in between the pillars (6)

3 *"Sing, O muse, of the man of many wiles who wandered far and wide after sacking the holy citadel of Troy"* (7)

4 Fertile South American lowlands, original home of suburban grass (6)

5 Term covering two different green minerals, one an amphibole the other a pyroxene (4)

7 Colloidal suspension of particles in gas (7)

9 (1930s) Gangster (7)

12 Son of King Lycurgus, among others, who lends his name to a group of stadials since 20,000 years BP (5)

14 Shrimp-like marine crustaceans of the O. Euphausiacea (5)

16 Foot-operated power source providing rotary or reciprocating motion (7)

18 Brown coal (7)

19 Found cropping out at surface (7)

21 Largest 20a of Japan (6)

22 Irregular body of naturally occurring native gold (6)

24 Wickedly mischievous spirits (4)

26 Desmond in a ballet skirt with a lower second? (4)

WIN A SPECIAL PUBLICATION

The winner of the May Crossword puzzle prize draw was Gary Robertson of Leatherhead, Surrey.

All correct solutions will be placed in the draw, and the winner's name printed in the September issue. The Editor's decision is final and no correspondence will be entered into. **Closing date - July 21**.

The competition is open to all Fellows, Candidate Fellows and Friends of the Geological Society who are not current Society employees, officers or trustees. This exclusion does not apply to officers of joint associations, specialist or regional groups.

Please return your completed crossword to Burlington House, marking your envelope "Crossword". Do not enclose any other matter with your solution. Overseas Fellows are encouraged to scan the signed form and email it as a PDF to **ted.nield@geolsoc.org.uk**

Name .....

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Membership number .....

Address for correspondence .....

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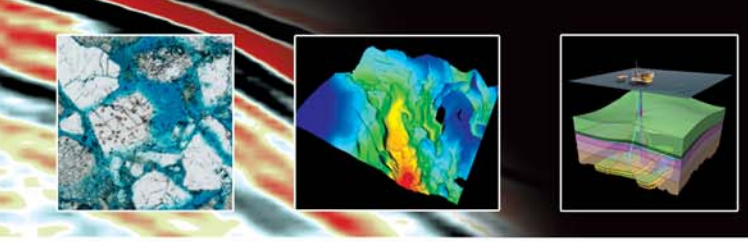
Postcode .....

SOLUTIONS MAY

ACROSS:
6 Mortlake **8** Offlap **10** Temple **11** Aseismic **12** Fossilize **13** IGCP **15** Augured **17** Aureole **20** Peat **21** Heterodox **23** Aberrant **25** Giants **27** Browse **28** Orthodox

DOWN:
1 Bode **2** Stapes **3** Keratin **4** Eocene **5** Bali **7** Arenite **9** Fissile **12** Flute **14** Calyx **16** Upthrow **18** Upright **19** Station **21** Hoaxer **22** Diatom **24** Bury **26** Tool



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Registration Now Open

East Africa
Petroleum Province of the 21st Century
24-26 October 2012

The Geological Society, Burlington House, Piccadilly, London

Conveners:

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Premier Oil

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Tullow

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East Africa was written off as an oil and gas province for many years. But the exploration campaigns of the last 5 years have changed that perception. Spectacular successes onshore Uganda and offshore Mozambique have attracted attention around the world and made East Africa an exploration hot bed of the second decade of the 21st Century.

Activity continues to pick up speed and is now expanding into neighbouring regions triggering a dramatic change in our geological knowledge of the basins being explored.

This conference will address the regional geological context, specific case studies and discuss the new and emerging exploration plays of East Africa. The meeting will bring together experts from industry, academia, seismic contractors showing the latest data, with keynote speakers from Anadarko, ENI, Tullow, Ophir, Fugro Robertson, BG Group and others.

There will also be a conference Dinner taking place at the Cavendish Hotel in Westminster on the evening of the 24th of October featuring a conference after dinner speaker, Tim O'Hanlon of Tullow Oil.

For further information, abstract submission and registration, please visit the conference website **www.geolsoc.org.uk/eastafrica12**

For further information, abstract submission and registration, please contact:
Steve Whalley, Event Co-ordinator: +44 (0)20 7432 0980 or email: steve.whalley@geolsoc.org.uk

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William Smith Meeting 2012

Strata and Time:
Probing the Gaps in our Understanding

4–5 September 2012

Burlington House, London, UK

An international conference to explore the relationship between the preserved strata of the rock record and the passage of geological time. Stratigraphic practice can only be as sound as the underlying assumptions relating strata with time. Our focus will be on identifying, evaluating and updating the models that lie behind stratigraphic methods. The scope of the conference will extend from the controls on preservation of strata in the record, through the qualitative and statistical properties of strata, to the implications for analysis, interpretation, modelling and prediction.

Sessions:

- Layers and completeness
- Sediment routing, processes and controls
- Subsurface/seismic methods and prediction
- Stratotypes and missing time

Keynote and Invited Speakers include:

Andrew Miall · Bradford Macurda · Roy Plotnick · John Tipper · Douglas Jerolmack
Cedric Griffiths · Philip Allen · Linda Hinnov · Vamsi Ganti

The 2012 William Smith Lecture will be given by Peter Sadler (University of California, Riverside) on *Scaling laws for the aggradation and progradation of the stratigraphic record*

Convenors:

David Smith · Robin Bailey · Peter Burgess · Alastair Fraser

A thematic set of papers will be published in the Journal of the Geological Society

Further information

For further information, including the conference programme, please visit the conference website at www.geolsoc.org.uk/williamsmith12

Enquiries to Naomi Newbold, Conference Office, The Geological Society, Burlington House, Piccadilly, London W1J 0BG

E: naomi.newbold@geolsoc.org.uk

Follow this event on Twitter #wsmith12

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