

GEOSCIENTIST

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The Fellowship Magazine of the Geological Society of London

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Ted Nield talks to Edmund
Nickless on his retirement

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2015 has been an extremely challenging year due to the oil price drop and the resulting budget and staff cuts. As ever, one of the first things to be cut has been exploration. After all who wants to find more barrels when you are losing money on the ones you already have. We will of course emerge from this downturn and reserve replacement and growth will be back on the agenda. The rig monster is now back in his lair and does not need to be continually fed with wells. More thoroughly worked prospects and considered selection of drilling targets will be the order of the day. In order to prepare for the upturn in exploration, it is time to plan for PROSPEX. This year has seen only a limited number of exploration wells drilled in the UK, but several initiatives have been started to help refresh the opportunity set for the future. These include evaluation of the Palaeozoic plays of the UKCS and new government funded seismic across the Mid North Sea High and the Rockall Trough. Now is the time to regroup with your peers to absorb these initiatives and create new opportunities for the drill bit.

As ever, the focus will be on networking, after all we are a joint venture industry. Opportunities to exchange ideas include the popular booths on the exhibition floor and the wine reception on the evening of the 9 December. This year we will also be running a quiz on the prospects being marketed, so make sure you fill in your form and have a bit of fun in the process.

Conversations can continue at the PESGB President's Evening on 10 December.

PROSPEX 2015 includes speakers from government, consultants and explorers to provide a context for the exhibition which is the main networking focus of the event.

Colin Percival

Joy Gray

PG | **PARKMEAD
GROUP**



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pesgb.org.uk **pesgbblog.org.uk**

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IN THIS ISSUE...

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Ragnarsdottir and Sverdrup apply Hubbert's concept to other Earth resources and conclude 'the world is fast moving toward its limits'.

**ONLINE
SPECIALS**

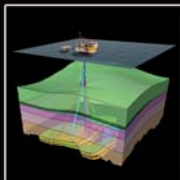
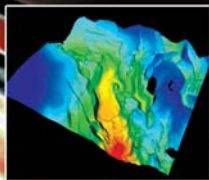
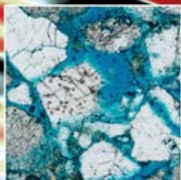
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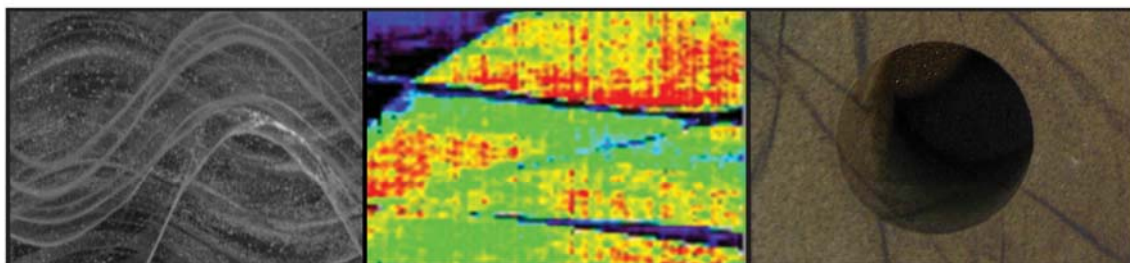
Registration Now Open

The BGS Open Day

an insight into the resource, techniques and methods
available for cost-effective reservoir description

11 November 2015

British Geological Survey, Keyworth



The hydrocarbon industry is confronted with exploring for and producing from ever more complex and challenging reservoirs at a time of lowered oil prices. In this 'new world' the need for more incisive reservoir description and characterisation from which more representative reservoir models can be built is of increasing importance to the effective exploitation of both proven reserves and new discoveries. In a cost-conscious commercial environment this means maximising value from existing resources, adding value and having the courage to exploit technologies new to the hydrocarbon industry.

This 1-day workshop at the BGS Keyworth facility addresses these issues via a series of oral presentations, core viewings and laboratory tours. At the 'heart of the day' is the BGS facility – a national archive of geological data. A presentation and laboratory tours will enlighten the participants to the breadth and depth of this major resource. Keyworth provides the ideal 'context' for the presentations and linked core viewings, which will explore:

- the importance of planning, management, interpretation and integration of RCA data;
- the value of integrating data from traditional and new sources – a combined core, helical CTscan and BHI study focuses on the improved recognition, description and interpretation of subseismic tectonic features (deformation bands), and sedimentary structures that evade the 'naked eye' in core, and the establishment of their true azimuthal orientations;
- the potential of new techniques (to the hydrocarbon industry) in the form of Infra-Red Spectroscopy (IRS) – a non-destructive mineral analytical technique that provides continuous (rather than point) mineralogical data across the entire imaged core. The technique also has applications to the recognition and mapping of solid and liquid hydrocarbons and their interaction with tectonic and sedimentary features.

The core viewings will demonstrate the nature and complexity of features that have 'directional significance': deformation bands, sandstone injections and soft sediment deformation features, and discuss how these techniques can be applied.

Registration

To register for this event, please visit the webpage: www.geolsoc.org.uk/PG-BGS-Open-Day or contact laura.griffiths@geolsoc.org.uk



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“THE WORLD IS FAST MOVING TOWARD ITS LIMITS.
WE SEE PEAK BEHAVIOUR IN MOST STRATEGICALLY
IMPORTANT METALS, MATERIALS AND FOSSIL FUELS”

Front cover image: © MarcelClemens/Shutterstock.com

FROM THE EDITOR'S DESK:

Dying for science

This year three members of my
profession have been brutally
murdered in Bangladesh,
bringing the grisly total to six
since 2013.

On May 12, 32 year-old blogger
Ananta Bijoy Das was hacked to death
by a masked machete-wielding gang in
Sylhet. He had received a number of
threats from Islamist militants, and his
name had appeared in two assassination
lists alongside those of other secular
bloggers, described as 'anti-Islamic' and
'blasphemous'.

Earlier, on 26 February, writer Avijit
Roy, a US citizen, was similarly executed.
Together with his wife Rafida Ahmed
Bonya, he was attacked close to Dhaka
University. Rafida was severely injured.
A militant Islamist group has reportedly
claimed responsibility for this atrocity.

On March 29, blogger Washiqur
Rahman Babu was murdered 500 metres
from his home in Begunbari, Dhaka.
Attackers targeted the 27-year-old
because they believed he had defamed
Islam.

International condemnation of these
senseless murders has been swift. John
Ralston Saul, President of PEN
International, summed up the general
feeling when he wrote: 'The
government, and the Prime Minister in
particular, have the responsibility and
the ethical obligation to stop this
violence and to ensure that Bangladesh
meets acceptable standards of both

democracy and the rule of law, which are
needed to protect citizens' right to free
expression.'

But, as Nigel Hughes (Professor of
Geology, University of California,
Riverside) has written*, there is more to
this than the need to protect freedom of
expression from ignorant fundamentalist
bigotry, something that is as much of a
threat at home as it is abroad.

He wrote: '...on the very day that
Roy...was bludgeoned to death yards
from where he was signing copies of his
latest astronomy book, another
American stood on the floor of the
Senate with a snowball in his hand, and
claimed that what his gut told him was a
better basis for preparing for the future
than the scientific contributions of
thousands of individuals the world
over... who have built an understanding
of what nature is telling us about our
planet's past.

'In that sense, [Senator James Inhofe,
Oklahoma] stands not with Roy, Rahman
and Das, but with those who opposed
them. This is why the deaths of these
three science advocates in Bangladesh ...
is a matter of consequence the world
over. They died because they
understood that the risks of ignoring
what science tells us are too serious to
indulge political ambition, clothed in a
supernatural mantle, wherever it occurs.'

* **Reference** *Dying for a natural explanation*
by Nigel Hughes, Huffington Post 29.7.2015.
W: <http://huff.to/1M96d6P>

DR TED NIELD, EDITOR - ted.nield@geolsoc.org.uk @TedNield @geoscientistmag

SOCIETY NEWS

What your society is doing
at home and abroad, in
London and the regions



Council nominations

Would you consider standing for Council? The call for nominations to the trustees is now open, writes Executive Secretary Sarah Fray.

Are you willing to contribute to the work of the Society not only by becoming a member of Council and one of its standing committees, but also by serving on working groups and undertaking particular tasks between meetings?

Whatever your background and expertise in geoscience, membership of Council enables you to influence the role of the Society in acting as a respected voice serving society and the profession.

You will be able to play an active role in the formulation and delivery of the Society's scientific and professional strategy, and help to facilitate the communication of new scientific findings, engage with and translate knowledge and expert advice to society, policy makers and government, and to certify good practice in the geoscience professions and teaching.

Trustees

Each of Council's 23 members is a trustee of the Society. Trustees are accountable to the Fellows and other stakeholders and regulators, such as the Charity Commission. The prime responsibility of trustees is to oversee the affairs of the Society and to act prudently in managing its financial resources.

Council meets five times a year, usually on a Wednesday. Four of those meetings take place in the afternoon beginning at 14.00 and finishing at 17.00. Papers are circulated a week in advance. In addition there is a two-day residential meeting in late September beginning on the afternoon of the first day and finishing mid afternoon the following day. Its purpose is to allow Council to discuss issues such as strategy, business planning etc.

Standing committees

All members of Council also serve on a standing committee – External Relations, Finance & Planning, Professional, Publications & Information and Science. Standing committees usually meet in person quarterly, though some have developed the practice of having three in-person and one virtual meeting.

From time-to-time all standing committees may establish short-lived working groups which could impose a further call on the time of Council members but in agreeing to stand for Council you should expect a time commitment of 8 to 10 days annually (for ordinary Council members).

Fellows have received a nomination form with this month's Geoscientist. Details of the nomination process are on the form and also in the 'Governance' section of the website. Nominations must be received no later than noon, Friday 8 January 2016 and they will NOT be valid unless they are fully completed, signed and accompanied by a statement by nominees.



LONDON LECTURE SERIES

Mud, Earth surface processes, and time

Speaker: Dr Angela Coe **Date:** 21st October

Programme

- ◆ Afternoon talk: 1430pm Tea & Coffee: 1500
Lecture begins: 1600 Event ends.
- ◆ 1730 Tea & Coffee: 1800 Lecture begins: 1900
Reception.

Further Information

Please visit

www.geolsoc.org.uk/shelllondonlectures15.

How 'glorious' is mud as a medium for recording Earth surface processes and the passage of time? Speaker Dr Angela Coe (Open University) answers 'excellent', because its near-continuous deposition allows detailed reconstruction of chemical weathering rates, sea-level change, carbon cycle change, oxygenation, and the effects of global climate variation on life.

Entry to each lecture is by ticket only. To obtain a ticket please contact the Society around four weeks before the talk. Due to the popularity of this lecture series, tickets are allocated in a monthly ballot and cannot be guaranteed.

➤ Contact: **Annie Sewell**, The Geological Society, Burlington House, Piccadilly, London W1J 0BG, T: +44 (0)20 7432 0981 E: Annie.Sewell@geolsoc.org.uk



Appy birthday



The Society and Esri have produced a special app for the 100 Great Geosites project, writes Flo Bullough.

Following the success of the *100 Great Geosites* project last year, the Society has been working with Esri to produce a mobile app to showcase winning sites. This means you can now browse them when you're out and about in the field, on holiday or just on your morning commute.

You can use the app to search for sites near you, or simply browse the list and plan to take in a few on your next trip! You can

also toggle between a satellite map of the site, or use the road map to plan your route. The app is chock-full with images, site descriptions and links to further information.

➤ The app is available free, on both the iTunes and Google Play app stores, either by following the link to the landing page <http://bit.ly/1JhmQWZ> or by searching '100 Great Geosites' on the app stores.

Extended Access to Journals

GSL is pleased to offer a new combined online journals package from 2016, writes Anne Davenport.

The new package includes *Journal of the Geological Society* and *Quarterly Journal of Engineering Geology and Hydrogeology*. In 2016 the free journal options will be: JGS + QJEGH, OR *Petroleum Geoscience + Geochemistry: Exploration, Environment, Analysis*. Print copies can be made available for a small fee.

Fellows continue to receive FREE online access to the Book Archive, which includes Special Publications, Engineering Geology Special Publications and Memoirs published

before January 2013. Fellows also have the opportunity to extend their online access to include all new and recent books by subscribing to the Full Book Collection – over 475 titles - for a small additional fee.

Geofacets GSL Millennium edition is a popular subscription offering Fellows exclusive personal access to over 24,000 geological maps from the Lyell Collection.

➤ These are just some of the benefits available to Fellows. For the full list, go to **W: www.geolsoc.org.uk/benefits**

NEWS IN BRIEF

First geologist on the moon - Harrison Schmitt and Apollo 17

The Geological Society Library, with the Royal Astronomical Society Library, is pleased to announce our next event, 'First Geologist on the Moon' - a recreation of the 28th William Smith lecture originally given by US astronaut Dr Harrison H Schmitt on 19 December 1973.

Schmitt was part of the crew of Apollo 17 (December 1972), the last of NASA's manned lunar landing missions. Schmitt remains the first and only geologist ever to walk on the Moon.

The following year, Schmitt delivered a lecture on his experiences: 'Apollo and the geology of the Moon', before a packed audience: but such was the demand for tickets that the talk was also relayed from Burlington House to the British Academy, where extra seating was provided for 130.

Through the wonders of 1970s technology, Schmitt will be beamed live from 1973 to once more present his lecture at 7pm on Friday 23 October 2015, in the Upper Library of the Geological Society, Burlington House. Caroline Lam.



➤ Tickets, £12, go on sale 5 October. To book T: 020 7432 0999 or E: library@geolsoc.org.uk

SOCIETY NEWS...

The Geological Society Club

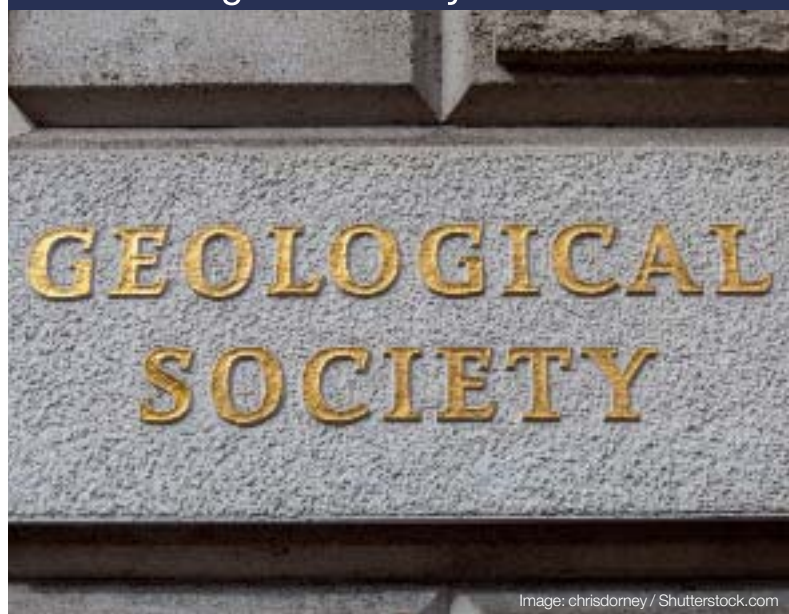


Image: chrisdorney / Shutterstock.com

The Geological Society Club, successor to the body that gave birth to the Society in 1807, meets monthly (except over the field season!) at 18.30 for 19.00 in the Athenaeum Club, Pall Mall, or at another venue, to be confirmed nearer the date. Once a year there is also a buffet dinner at Burlington House. New diners are always welcome, especially from among younger Fellows. Dinner costs £57 for a four-course meal, including

coffee and port. There is a cash bar for the purchase of aperitifs and wine. Burlington House dinners include wine.

◆ **2015:** 7 October (Athenaeum)

➤ Fellows wishing to dine or requesting further information about the Geological Society Club, please email Caroline Seymour on **E: carolineseymour554@hotmail.com**

CALENDAR

FUTURE MEETINGS

Dates for meetings of Council and Ordinary General Meetings until April 2016 shall be as follows:

Ordinary General Meetings:

- ◆ **2015:** 25 November
- ◆ **2016:** 3 February
- ◆ **2016:** 6 April

Meetings of Council:

- ◆ **2015:** 25 November
- ◆ **2016:** 3 February
- ◆ **2016:** 6 April



FROM THE LIBRARY

◆ Library newsletter

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➤ 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/info>

To Mediocrity

Following the Society's recent Awards to the great, good, up and coming of Earth science, **Lewis McCaffrey** * sings the praises of those who never win the glittering prizes



Awards season is with us again, like a prodigal relative, who turns up uninvited and reminds us of our own comparative inadequacy. We should congratulate the winners, of course; but spare some change for those who are, every year, left out of the celebrations.

In fact, new research shows that a large majority of UK geologists will never win an award. This research, done on the back of an envelope and destined never to be even submitted let alone accepted for publication, shows that around 0.002% of Fellows of the Geological Society will win one of its awards in their lifetime.

If this tiny percentage are the winners, then what does that make the rest of us? Not necessarily losers, I hope. I suggest that we are the merely mediocre.

No shame

There should be no shame attached to this label. Sure, the culture of 'excellence' is ubiquitous. We all strive to be outstanding. But we cannot all be 'above average', as geologists or indeed anything else. Only a scientifically illiterate Education Minister could utter a

statement saying that he will not rest until 'all schools are above average'.

Instead, I suggest that we should take heart from Sir Isaac Newton's assertion that he saw so far because he stood 'on the shoulders of giants'. Who, do you think, were the giants standing on? Yes, the scientists of medium stature, who were themselves probably standing on scientists of less than average height, performance-wise.

Indeed, how many Fellows of this Learned Society are employed where doing an unspectacular, predictable, competent job is absolutely required (and to do anything else is to miss the point)? The forward march of science relies, partly, on the competent, unimaginative repetition of someone else's research as verification. Don't forget this is what makes science so democratic. Even a mediocre scientist can make valuable if unremarkable contributions. Who wants to listen to a mediocre violinist? Science is kind to the ordinary. The arts are cruel, like nature.

Dalston & Gibbett

Those among us who view Dalston and Gibbett as our role models do a grand job of bulking out the bell curve of competence. We should be celebrated - even given an award - for outstanding mediocrity. But how to select the Most Mediocre Fellow; and who would show up to collect the award? Who would put it on their mantel, or show it off to their mother? Indeed, who in their right mind would pen a piece praising mediocrity, and attach their name to it?

So, as the new awards season gets under way, most of us will say a hearty "Well done!" to the winners (possibly through gritted teeth) as we return to our 'me too', Zombie research and our unexacting, routine positions. We will make a sufficient, mediocre job of it, and there should be no indignity in that.

***Lewis McCaffrey PhD FGS CGeol** is a moderately successful visiting assistant professor in the **Institute for a Sustainable Environment** at **Clarkson University, New York, USA**

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 – please take photographs on the largest setting on your camera, with a plain background.

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).

“**THOSE OF US WHO VIEW DALSTON & GIBBETT AS OUR ROLE MODELS DO A GRAND JOB OF BULKING OUT THE BELL CURVE OF COMPETENCE. WE SHOULD BE CELEBRATED**”

Lewis McCaffrey



Limits to Growth REVISITED



**Kristín Vala
Ragnarsdóttir and
Harald U Sverdrup***
put natural resources
into Global
Perspective

*Above: Velvety, blue Rosasite crystals.
Ore containing copper and zinc.
How long before these metals too
become scarce?*

In 1971, at the request of the Club of Rome, an MIT systems engineering professor called Jay Forrester developed a model for the future economy, showing that a resource crisis could be imminent. Aurelio Peccei, an Italian economist and industrialist and former boss of FIAT and Olivetti, realised that a more comprehensive study was needed to address the interplay between three factors - exponential population growth, global resources and environmental pollution.

The Club of Rome, of which Peccei was a founder and president, initiated the work that led to *Limits to Growth* (1972). This study was led by Forrester's PhD student Dennis Meadows, with help from Donella Meadows (a biochemist), Jørgen Randers (a physicist) and Willhelm Berents III (an agronomist). It had a global impact, and sold over 30 million copies in 30 languages.

But the debate soon became derailed, because LTG suggested curbing economic growth – an unwelcome idea to those who have a large stake in the status quo¹. Governments fear dwindling tax revenue, while mainstream economists resist any change to the paradigm of eternal growth. As any businessman knows, managing growth is a lot easier than either of the alternatives. Meanwhile, neither public nor policymakers appear to grasp that resources form the basis for economic growth.

ASPO

Oil-company geophysicists Colin Campbell and Jean Laherrere, together with physicist Professor Kjell Aleklett, founded the Association for the Study of Peak Oil (ASPO) in 2001. Their work built on that of Marion King Hubbert, who in the 1950s developed a model for

“WE MUST CHANGE COURSE BEFORE CAUSING IRREVERSIBLE DAMAGE TO THE ENVIRONMENT AND ITS LIFE-SUPPORT SYSTEMS”

Figure 2a

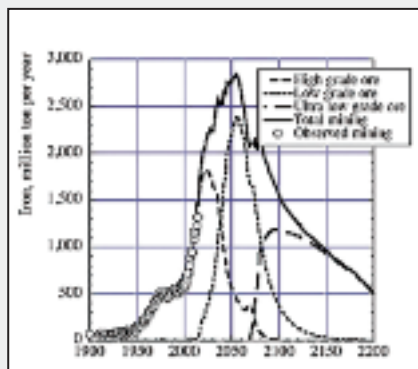


Figure 2b

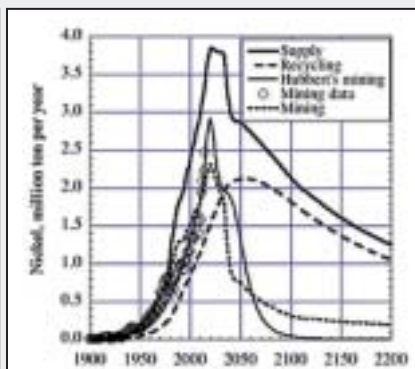


Figure 2c

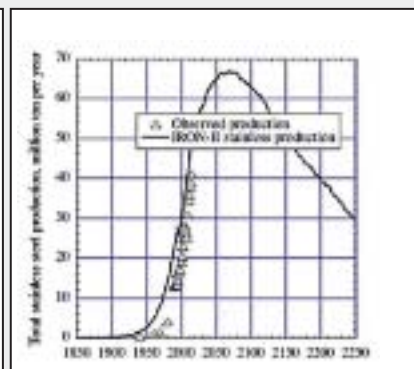


Figure 3a

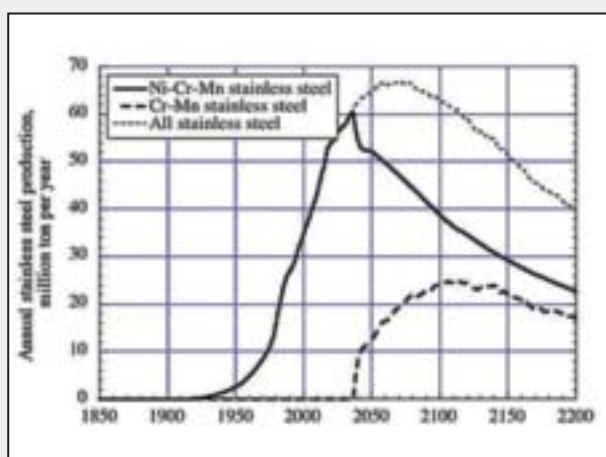


Figure 3b

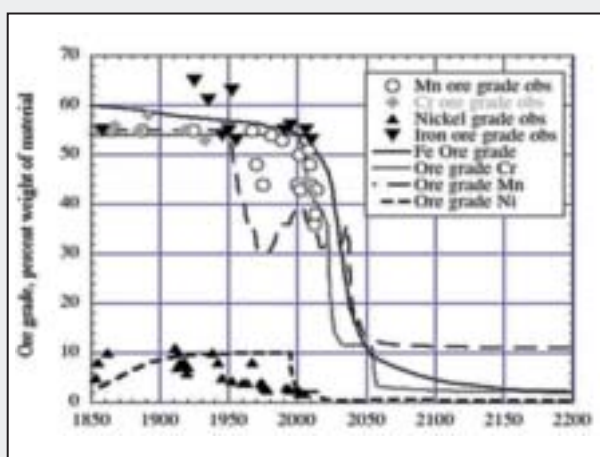


Figure 2. Data for mining rates and the total mining rate outputs for iron (a), nickel (b) and stainless steel (c), using the WORLD model and the Hubbert's model (b). Note that after 2080 recycling will be the dominant source of iron, and that after 2035, recycling is the dominant source of nickel

Figure 3. Production rate for Mn-Cr-Ni-based stainless steel and Mn-Cr steel without nickel (a) from the WORLD model. When we run out of sufficient nickel, stainless steel will be substituted with a simpler quality without it. (b) Data for ore grades (symbols) compared to the outputs from the WORLD model

oil production and field exhaustion, which has since been referred to as 'peak oil'. Hubbert (correctly!) predicted an exhaustion date for the oil and energy reserves of the United States as 1970. Campbell and co. tirelessly presented data at conferences showing that we were about to reach peak oil - and indeed this peak was reached in 2006^{2,3}.

The ecologist Charles Hall has extended the debate by defining the concept of Energy Return on Investment (EROI) for oil, demonstrating that as oil dwindles, so does EROI. It began with a ratio of over 100 in the 19th Century, but is going down because it costs more and more energy to get oil out of the ground as reservoirs get deeper (under the sea or ground) and refining costs rise as oil grade declines. EROI for oil stood around 40 in the US in 2005, is below 10 for deep oil, and around 2 for shale oil.

Meadows *et al.*) and updates of their

work^{4,5,6,7,8}) indicated what changes were needed to curb the exponential exploitation of natural resources. Based on integrated systems analysis and dynamics they presented several scenarios with future options, from which societies and policy makers could choose. Unfortunately the international community continued with the 'business as usual' scenario, generally referred to as 'the standard run'. The message of their work was, however, that we must change course before causing irreversible damage to the environment and its life-support systems for billions of people.

Australian geologist Graham Turner, revisiting the 'limits to growth' scenarios^{9,10} has demonstrated that we have however continued with the 'standard run'. We have recently published a comprehensive analysis, in the October 2014 issue of *Geochemical Perspectives*¹¹ which asks - do we still have time, or is it

too late for a change of direction to do any good?

Methods

We have used several different methods to assess resource availability. These are, in order of increasing complexity: Burn-off time (business as usual), peak discovery early warning, Hubbert's model estimates, and systems dynamics modelling. We describe these briefly here and at greater length elsewhere^{11,12,13}.

In our work the US Geological Survey is an important source of data and definitions, which we follow. A list can be found in the online version of this article.

In our models we work with all technically extractable ore content (below referred to as 'reserves') classified according to ore grade and extraction costs. The result is that that we will experience ever-rising costs as ore

Colin Campbell demonstrates peak oil at an Irish pub. The full glass represents oil resources in 1900, the half empty glass represents the year 2000, and the near-empty glass oil resources in 2010

Figure 1



Figure 4a

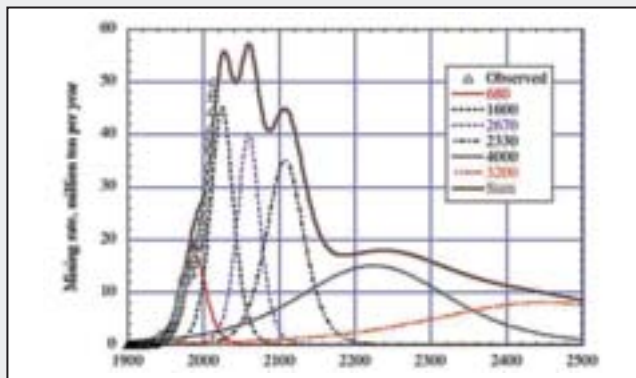


Figure 4b

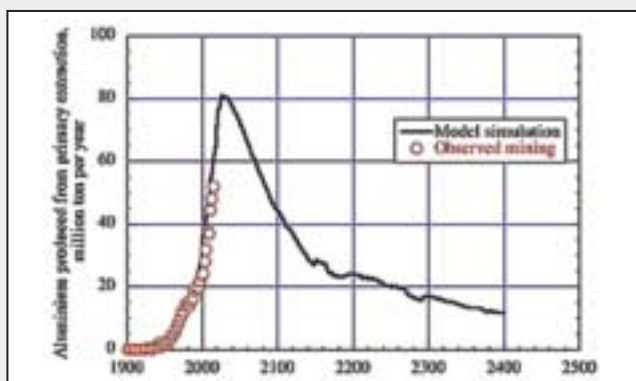


Figure 4c

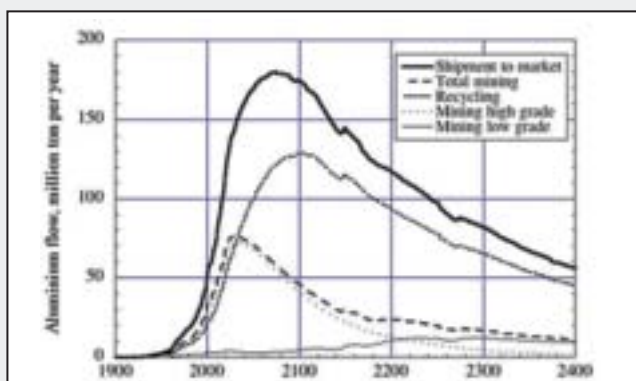


Figure 4d

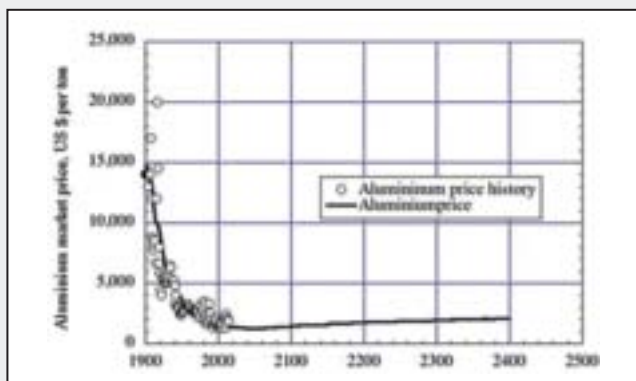


Figure 4. WORLD model simulation of primary aluminium production rate 1900-2500 using the same extractable amount; Hubbert's model (a) and the WORLD model (b). Aluminium mining compared to recycling and supply (c). Note the model predicts recycling as the main source of Al after 2020. Because of relatively efficient recycling, supply is much larger than the mining rate. WORLD model tested on how well it predicts market price for Al (d)

► quality and extraction yields go down.

Burn-off time is a 'worst-case scenario', and gives an order of magnitude indication for how long the reserves will last. Burn-off time is defined as estimated extractable reserves divided by the present net yearly extraction rate - the ratio between reserves estimated to be extractable, and present consumption, expressed in years. It is an indicator, rather than a robust time estimate, and should be used as such.

Peak discovery early warning: earlier work has shown that there is a systematic shift of 40 years between peak discovery and production peak for a large number of different metals, materials and fossil fuels^{12,14}. Thus, when we know the peak year in reserve discovery, we also know, 40 years ahead of time, when the peak production will come - with a good measure of certainty.

Misconception II

Hubbert's model estimates of peak production and time to scarcity was set forth by M. King Hubbert (Shell Oil), when he developed the Hubbert curve, from 1956 on, to predict the lifetime of wells and fields. He showed, using observed production data for oil wells (as well as uranium and phosphate mining), that all finite metal, material and fossil fuel exploitation follows the distinctive pattern of the Hubbert normal curve. Hubbert verified this model using field data several times over.

We have often been told that Hubbert curves 'cannot be applied to metals'. But we have tried them on reserves data for more than 40 metals, minerals and materials, and tests on field data demonstrate that they work excellently, on any non-renewable mined geological reserve¹⁵.

System dynamic modelling was used to reconstruct the past for explanatory and testing purposes - to estimate time to production maximum, and to study the rate of decline to scarcity, after maximum production has passed. The flow pathways and the causal chains and feedback loops in the system are mapped using systems analysis, and the resulting coupled differential equations describing these feedbacks are transferred to computer code for numerical solution, using an environment such as STELLA®. The methods are those used in systems

Figure 5

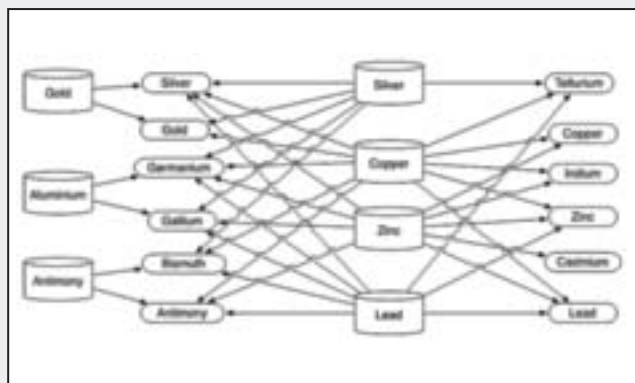


Figure 5. Interconnected flowchart of the parent ores of copper, zinc and lead, as modelled with BRONZE (submodule of WORLD). Cylinders represent reserves, ovals the production for each metal

analysis and systems dynamics for modelling complex systems^{8,16}. This method gives more detail, demands more insight and can include more factors, but is more difficult to parameterise.

The WORLD model, used to produce the runs presented in this study, is similar to the approach taken by Meadows *et al.* in their World3 model, and presented in LTG. However, World3 lumped extractable amounts for energy, metals and all materials, missing the dynamics that arise when they are presented as coupled but separate, as here. Contrary to many claims, the Meadows team did not 'confuse resources and reserves' (as defined by the USGS – see online). Interested readers are pointed to the scientific background document⁴ and *Limits to Growth*⁵, aimed at the public. The 'standard run' of LTG has been shown, 40 years later, to be correct^{9,10}. Materials however can be recycled, whereas much energy cannot. This is being corrected in our WORLD model, currently under development¹¹.

Metals modelled

Applying our analysis to over 40 natural resources of metals and materials, we find that most have either reached peak production, or will do so before 2050 (See Table, available Online). We have selected to show here the results for some of the metals most important to society: iron (1450 million tons per year primary extraction), manganese (18 million tons per year), chromium (16 million tons per year) and nickel (two million tons per year).

Iron, and steel made from it, constitute the most important metals for society. Stainless steel is a composed metal mixture made from iron, manganese, chromium and nickel (50 million tons per year). We also discuss aluminium (50 million tons per year), copper (16 million tons), and zinc (11 million). Table ¹ (online only) presents outcomes for peak production and time to scarcity, using our four estimation methods. Analysis of the results in the table, shows that results obtained by using the different methods are in broad agreement.

An example of systems dynamics model outputs is given here in Figure 2 and Figure 3. Figure 2 shows outputs from the WORLD model for iron, nickel and stainless steel. When nickel runs out, high quality steels will be difficult to make. Figure 3 shows the production rate for Mn-Cr-Ni stainless steel and Mn-Cr stainless steel without nickel. It shows that when we run out of sufficient nickel,

Figure 6a

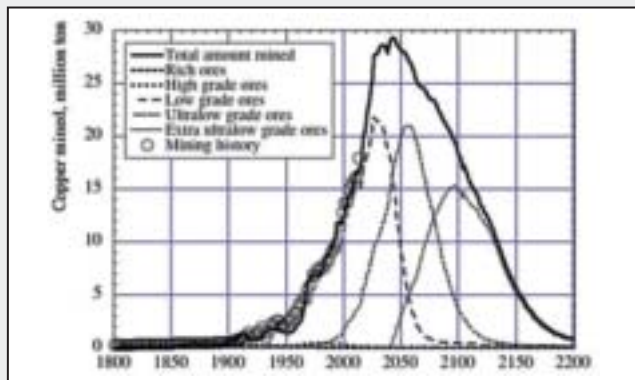


Figure 6. WORLD model output mining rate for copper (a) and zinc (c), total copper supplied to society and amount recycled (b). Decline in ore grades (d); both WORLD model (lines) and observed ore grade (symbols) are in agreement. Note: after 2050 recycling will be the dominant source of Zn and Cu

Figure 6b

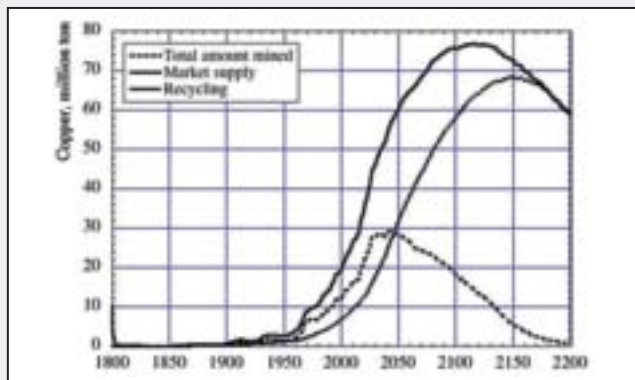


Figure 6c

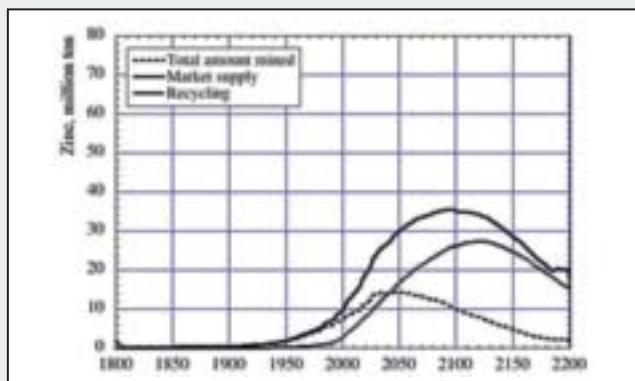
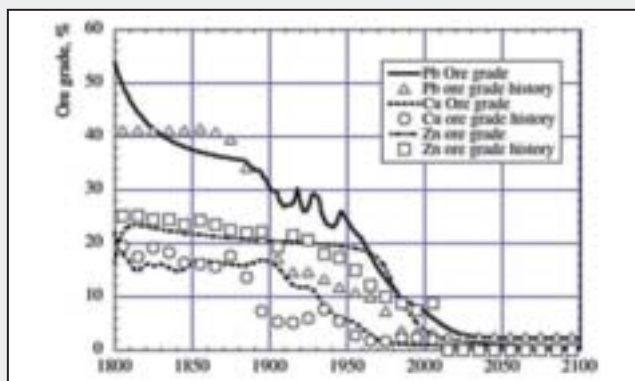


Figure 6d



► stainless steel will be substituted with a simpler quality, without nickel. In the diagram, the recycling rate (30-60%) driven by price, was included. It shows how the grades are predicted to fall in the next decades, driving up metal prices and making them more difficult to obtain.

Figure 4 shows a simulation of primary aluminium production rate from 1900 to 2500, assuming the same extractable amount using the Hubbert's (a) and the WORLD models (b,c). The model was tested on how well it predicts the market price for aluminium. Comparing aluminium's 'modelled' price to real data, we get $r^2 = 0.81$ - a good validation of the dynamic model's performance. The model generates the price internally and uses it to feedback into supply and demand.

The interconnected flowchart for submodule BRONZE of the parent ores of copper and zinc, as modelled with the WORLD model, is shown in Figure 5. The extraction of many technologically important metals are linked to the production of copper, zinc and lead and depend on their rate of mining. Figure 6 shows the copper (a) and zinc (c) mining rate, the total amount of copper supplied to society compared to recycled metal

(b). Ore grades are predicted to fall (d), and our simulations closely match the actual ore-grade. Historically, ore grade was compensated for by three factors: mechanisation (1900-1960), doing more of the work in low-wage countries (1960-2000) and automation (1990-2010). As we run out of poor countries, where workers can be paid even less, and as energy costs increase, resource prices will rise.

Figure 7 shows further outputs from the WORLD model compared with actual extraction rates for indium (a) and germanium (b), two examples of metals vital to present and future technologies. These metals are all dependent on mining of polymetallic ores containing copper, zinc and lead, and will reach peak production when copper, zinc and lead mines reach their peak.

Figure 8 shows GOLD model (a WORLD submodel) assessment for gold production from mines (a); the dots represent observed data. Gold has always been scarce, and its world use is therefore well adapted to scarcity and supply limitations. The ore grade for gold over the last 100 years was modelled with good accuracy - showing that the models do describe what is actually going on (b).

The WORLD systems dynamics models used here differ from traditional economic models in being strictly 'causality based' and 'mass balance limited'. Econometric models do not possess these properties, and so cannot predict prices. Thus, they often fail and have limited predictive value.

Figure 9 shows that peak oil production was passed in the period 2008-2010. Coal's peak falls between 2015-2020, while peak energy will also occur then. Peak wealth will arrive around 2017-2022, all based on 140 years of reservoir data and production rates³. From that point on, we will no longer be able to take natural-resource-fuelled global GDP growth for granted.

Scarcity matters

Resource scarcity manifests itself in several ways. The first will be price instability, which later becomes systematically higher prices. Scarcity is also indicated by steadily sinking ore grades and increasing extraction costs, pushing price up. This sometimes reduces demand, softening the blow. Only at a much later stage does physical scarcity occur. Platinum group metals are already scarce; price is already very high, and there are limits

Figure 7a

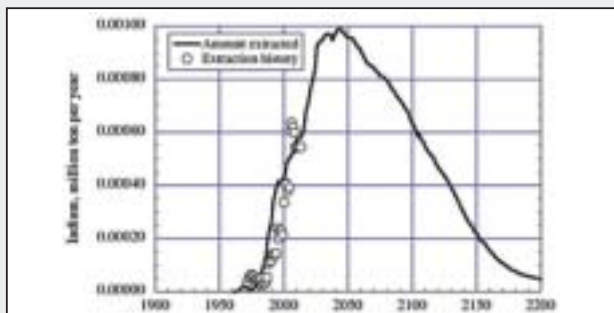


Figure 7b

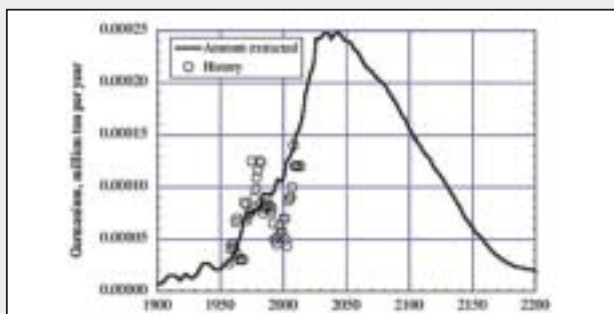


Figure 8a

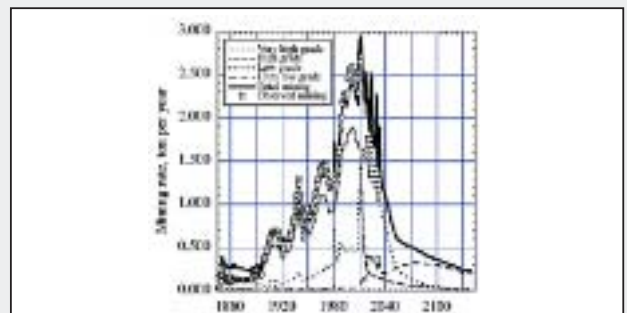


Figure 8b

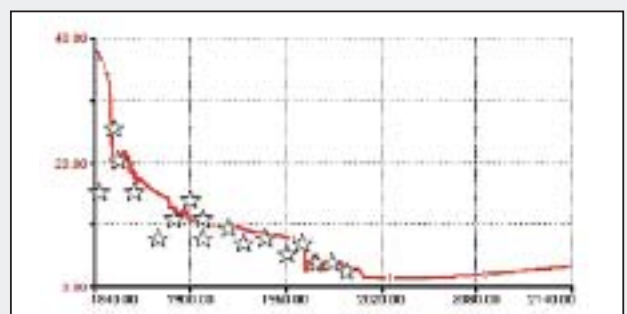


Figure 7. Extraction rates for indium (a) and germanium (b) from the WORLD model compared (lines) with actual extraction (open circles)

Figure 8. (a) GOLD model assessment for gold production compared with observed mining rate (dots). (b) GOLD model output for ore grade compared to historical ore grade (stars)

to how much can be supplied. We may run out of money before we run out of materials.

Our resource Table (Online only) shows four different estimations of risk for scarcity expressed as burn-off years, date for peak production and simulated peak supply to society - including conservation measures like recycling. We have also assessed the overall risk at different time intervals considering all methods. Estimates are consistent, and give scarcity risks very close to the present time. Production of energy, metals for technology and infrastructure and phosphorus for food, are all closely linked and interdependent. Many peak years occur within a few decades - making the appearance of problems much more risky and serious. Just sitting and waiting may prove a disastrous strategy, leaving us no time for proper action until it is too late. We cannot afford to fail on any of these resources, if the world system function is to be preserved.

A way forward?

The world is fast moving towards its limits. We see peak behaviour in most strategically important metals, materials and fossil fuels that are fundamental to

running our societies. The continuing financial crisis since 2007 is not only a financial crisis, but one that showed how resource-backed economic growth cannot be sustained because of the physical limits of the world^{5,11}.

In a world of limits, planning for further economic growth is a fool's policy that will fail. Many influential people remain stuck in denial of the finite nature of resources, and this is a significant problem. A global population too large for a world where resource extraction has physical constraints will, most likely be one living in great poverty. As resources decline and population rises, the situation will worsen. It is one of the largest challenges ever faced by mankind.

Long after all the gold mines have been exhausted, gold will remain with us because of recycling: we never lose any, always recycle it, and really look after it, because gold is scarce and has high value. If this is possible for gold, then it is possible for other metals. The key is systemic recycling for all metals and materials^{17,18}.

Every problem is a challenge, every challenge is an opportunity, every opportunity turned into a solution is a success. Solutions must be found. All of us, including geologists, need to rise to

the occasion. Business-as-usual is the worst case scenario. There are many possible ways forward, many solutions to develop, and much change will be needed to make it all work. For example, new development indicators are needed, that go beyond natural resource-fuelled GDP growth^{17,18}.

Key policies needed include: Recycling, and developing models for an economy that converges within the sustainability limits. It may be cyclic or steady state, but it must and will stay within the limits of sustainability. If we do not do this, mass balance and thermodynamics will enforce it anyway.

We can all learn from Peter Seeger: 'If it can't be reduced, reused, repaired, rebuilt, refurbished, refinished, resold, recycled or composted, then it should be restricted, redesigned, or removed.' ♦

➤ **References** are available in the online version **Editor**.

***University of Iceland, Reykjavik, & School of Engineering & Natural Sciences, Faculty of Earth Sciences, Askja, Iceland.**

Figure 9

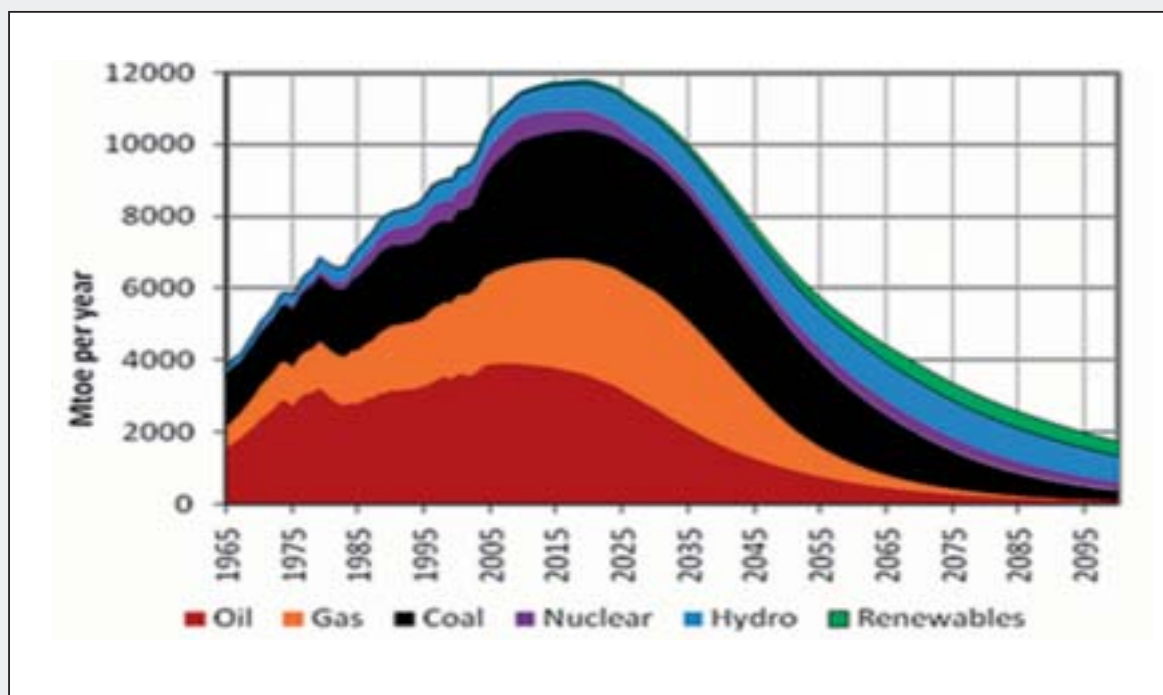


Figure 9. Fossil fuel production over time. Note how dominant fossil fuels are and how small renewables are. We will have to make do with very much less energy in the future. (Association for the Study of Peak Oil, 2007)

SOLID

FOUNDATION



Geology lies at the heart of a public consultation about radioactive waste disposal, due to close in early December, writes **Natalyn Ala***

Radioactive Waste Management (RWM), the organisation designated by Government as the developer of a geological disposal facility (GDF), is planning to bring together existing geological information, at a national scale, relevant to the safety of a geological disposal facility. We want to provide authoritative information that can be used in early discussions with communities. Individual members of the Geological Society can engage in this exercise by contributing to the consultation and sharing their insights and views.

Nuclear nation

Britain has been a nuclear nation for 70 years. The world's first commercial nuclear power station was opened by the Queen in 1956 at Calder Hall in Cumbria. However, in the early days, little thought was given to the long-term management of the resulting radioactive waste.

It has become increasingly clear that such a position is neither environmentally nor ethically sound. As the generation that has benefited from nuclear power, it is our responsibility to find a permanent solution to the challenge of radioactive waste.

An extensive independent investigation over a decade ago concluded that geological disposal was the best available solution. Geological disposal is also the preferred option in other countries across the globe, including Sweden, France, China, USA, Canada and Germany and a number of countries are well advanced in implementation.

The principle of a GDF is to isolate radioactive waste from the surface environment and contain it for long enough to prevent harmful quantities of radioactivity ever reaching the surface. While for most types of waste, this means a few decades, some waste components remain highly radioactive for hundreds of thousands of years.

Interim waste stores at today's power stations are actively managed, continuously monitored and maintained; but a solution that will be relied upon for many millennia requires a 'passive'

management system. The physical environment has to play a major part in the containment process.

Safety is the first priority in radioactive waste management and RWM will not proceed with construction until it can demonstrate the safety of the facility to our regulators. Geology is one of the key elements of the environmental safety case for a GDF.

Consultation

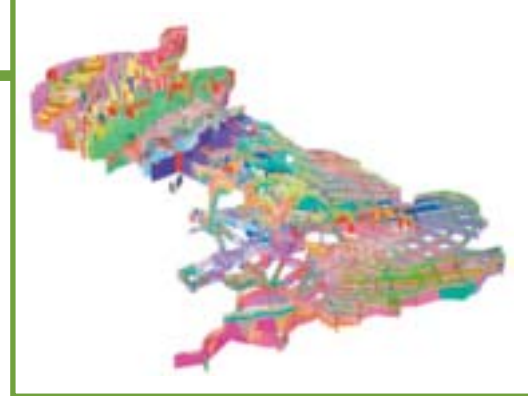
A Government consultation in 2013 showed that people want to know more about the sub-surface environment in order to inform early discussions about the potential to host a GDF. That is why one of the first activities outlined in the 2014 White Paper¹, *Implementing Geological Disposal*, is an exercise to gather together relevant existing geological information for England, Wales and Northern Ireland (Scotland has a different radioactive waste policy).

A National Geological Screening (NGS) exercise will therefore take place in 2016 to gather existing geological information relevant to the environmental safety case. It will also identify what is not known at this stage. Uncertainties about sub-surface geology increase with depth. So this exercise is not just about what we know and don't know, but also about understanding uncertainties.

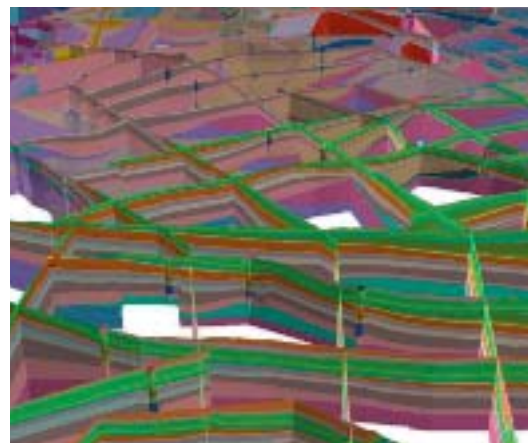
A GDF will be constructed between 200m and 1000m depth. The expanse and type of suitable rock available will be crucial in terms of the confirmed underground space required and its integrity and ability to safely store waste materials.

Not all of our geological knowledge is relevant to the safety of a GDF, particularly at this preparation stage. When the siting process begins in 2017, and communities come forward wanting to learn more, then more detailed local information will be collected.

An approach has been developed by RWM with support from the British Geological Survey (BGS) and specialist geoscience professionals. This seeks to identify those geological attributes (i.e. characteristics of the geological environment) relevant to long-term safety



Above right: Images of the sub-surface. The GB3D geological model uses digital cross-sections of the geology across Great Britain and joins them up in a 'fence diagram'. Source: BGS. A computer image from GB3D, showing boreholes. Source: BGS.



Above left: Roadway in Onkalo (Underground Rock Characterisation Facility), Finland – a repository in a 'hard rock' setting

Lower left, left: Olkiluoto facility, Finland. Onkalo spent nuclear fuel repository, a deep geological repository for the final disposal of spent nuclear fuel, is the first such repository in the world. It is currently under construction at Olkiluoto (foreground)

Lower left, centre: Reactor facility at Calder Hall, the UK's first functioning nuclear reactor. The early nuclear industry did not give much thought to long-term solutions for radioactive waste.

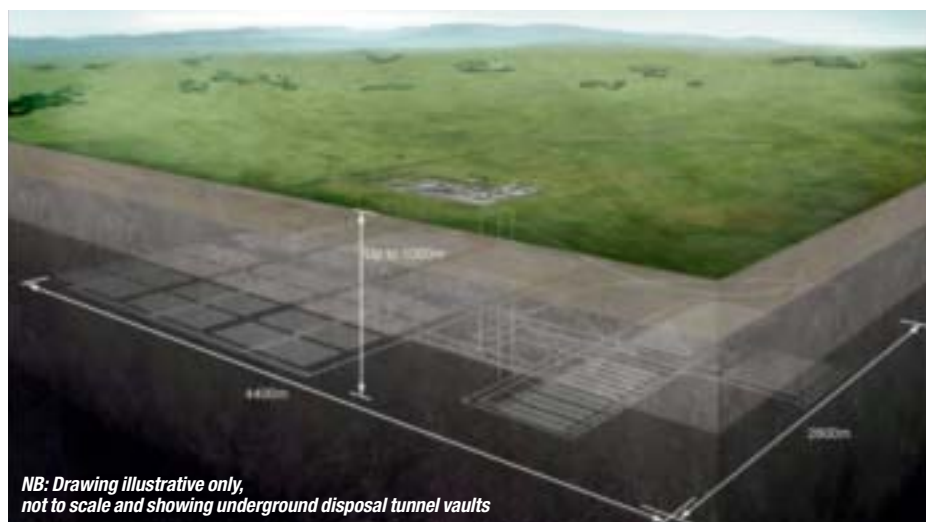
Lower left, right: Mont Terri facility in Switzerland – a repository in lower strength sedimentary rock

requirements, and also to catalogue existing sources of information. Advice has also been received from RWM's Technical Advisory Panel and its Nuclear Safety and Environment Committee. In addition, comments were provided by Regulators and the Committee on Radioactive Waste Management.

Screening

As required by the 2014 White Paper, geological screening is based on characteristics of the geological environment relevant to the long-term safety of a GDF and the requirements of the existing GDF safety cases. The five attributes are: rock type, rock structure, groundwater, natural processes, and resources.

◆ **Rock type attributes** concern the nature and properties of the rocks present in the subsurface, including the characteristics of potential host rocks in the appropriate depth range and those of surrounding rocks that could contribute to safety. ►



NB: Drawing illustrative only, not to scale and showing underground disposal tunnel vaults



Above: The Waste Isolation Pilot Plant (WIPP) in the United States – an evaporite setting

Left: Artist's impression of a GDF for the UK, in higher strength rock

► Suitable host rocks will potentially have low groundwater flow and are considered in three broad types (higher strength, lower strength sedimentary and evaporite rocks). They must be located at sufficient depth to ensure that the waste is isolated from the surface environment and have sufficient extent to accommodate the GDF. Surrounding or overlying rocks may also contribute to safety.

◆ **Rock structure attributes** concern the three-dimensional form and arrangement of different rock types and particularly the presence of geological features at depth, such as folding, faults and highly-fractured zones, which will influence the uniformity and predictability of rock properties and groundwater flow. An understanding of these attributes is important in characterising a site and demonstrating an understanding of its expected evolution. Faults often indicate locations where there is a change in the deep groundwater regime.

◆ **Groundwater attributes** concern the movement and chemical composition of groundwater present in pores and fractures in rocks from surface to a depth of around 1000m. Groundwater saturates the pores and fractures in most UK rocks below a few tens of metres depth and, where these pores and fractures are interconnected, water can move through the formations. Radionuclides and other toxic materials can be transported in groundwater from GDF depths to the surface environment. This transport is influenced by the volume of water present in the host rocks, its rates of movement and pathways to the surface environment. Slow groundwater movement and long return times are favourable for safety.

◆ **Natural processes attributes** provide information on processes such as sea-level change, erosion, earthquakes, regional uplift and the growth and retreat of ice sheets and glaciers, which are relevant to maintaining the safety of a GDF over very long timescales. Such processes are influenced by tectonic stress and by long-term climatic drivers. Favourable conditions are those where the anticipated natural processes are sufficiently slow and are adequately understood so that their consequences can be shown not to compromise the safety of the multi-barrier system.

◆ **Resources attributes** include the locations of hydrocarbon and mineral resources that are known or suspected at depth. They are relevant to GDF safety because a future society, unaware of the presence and purpose of a GDF and seeking new resources, may unwittingly drill or mine the area in which it is situated, potentially affecting the geological environment and the function of the multi-barrier system. In addition to minerals and conventional hydrocarbon resources, information will also be gathered on coalbed methane, shale gas and geothermal resources.

International panel

At the request of the Department of Energy and Climate Change (DECC), the Geological Society brought together an international panel of geological experts to review the technical robustness of the draft guidance. At an event on 23 June, we responded to their questions and have incorporated their comments within an updated version of the guidance. The resulting draft guidance forms the basis for a public consultation running

over the autumn. This is an opportunity to invite comments and views from a much wider community. At the end of this period RWM will carefully assess all the contributions and then produce a final version of the guidance.

The guidance will be used to produce information materials for communities who may wish to talk to RWM about their potential to host a GDF. The outputs of screening will be a series of brief narratives describing the key characteristics of the geological environment and their relevance to safety. The narratives will be produced for 13 regions of England, Wales and Northern Ireland (aligned to the regional guides adopted by BGS). The narratives will be illustrated with maps, where appropriate.

As geology is a fundamental element in the long-term safety of a GDF, we hope as many members of the Society as possible will read about what we are doing and respond to the consultation.

◆ **The public consultation** on the National Geological Screening (NGS) exercise opened on 8 September 2015 and will close on 4 December. It can be found on the RWM website at: <http://bit.ly/1US7Fde>. ◆

* **Natalyn Ala** is GDF Siting Director for Radioactive Waste Management (RWM). She is a Fellow of the Geological Society, Council member and Secretary of the Society's Professional Committee

REFERENCE

- 1 <https://www.gov.uk/government/publications/implementing-geological-disposal>

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Study the ground beneath your feet



Sir, In February 1966 Laurits Bjerrum delivered the Third Terzaghi Lecture titled, 'Progressive Failure in Slopes of Plastic Clay and Clay Shales'. In the lecture, and the subsequent paper, he demonstrated that strain produced by lateral unloading, after excavation of a slope, caused progressive development of slip surfaces along which the angle of shearing resistance reduced towards a residual value. Bjerrum included numerous case studies including the famous failures after the excavation of the Panama Canal.

Covering around 3000km², the coal mining valleys of South Wales (UK) have one of the highest concentrations of landslides in Western Europe (Bentley & Siddle 1996). Many are deep-seated and have curvilinear slip surfaces where the linear sections follow the ~5° dipping bedding planes in the mainly argillaceous Rhondda Beds (Bentley 2000; Bentley & Siddle 2000).

For about 100 years the valleys were the home to over 620 collieries which mined subsurface coal in up to eight seams at depths of between 75 and 300 metres below the valley floors. Mechanised during the 1930s, the total-extraction long-wall mining and the resulting

subsidence caused significant tensile strains over transient and permanent mining edges. Repeated up to eight times, could these waves of strain equate to lateral unloading and ground movements accommodated in bedding planes along which the angle of shearing resistance moved towards residual values – mining subsidence driving progressive failure and as the slip surface lengthens, and in combination with other causal factors such as pore water pressures, the slope fails?

Many of the deep-seated, curvilinear landslides are well-documented and occurred during the mining era. Interestingly, there are others which are much older possibly periglacial in age (for example, Troedryhiw in the Taff Valley, No51.7131 Wo-3.3390). Could lateral unloading by ice be another driver of progressive failure?

Could many of the recent landslides (1860 to 1960) be products of both mechanisms where the progressive development of slip surfaces is initiated by deglaciation and lengthened to the point of failure by mining subsidence?

STEPHEN P BENTLEY, READER IN ENGINEERING GEOLOGY, CARDIFF SCHOOL OF ENGINEERING, CARDIFF UNIVERSITY.

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STICKS AND STONES.



Geology and Geophysics of the United Arab Emirates



These 12 volumes and the accompanying maps with descriptions produced by the BGS for the UAE Ministry of Energy provide a comprehensive and up-to-date account of the geology, geophysics, resources and geological hazards of the UAE.

Three volumes are likely to be of interest to the general reader: one on the geology and evolution of the western part of the Hajar mountains (V2), and another on the geology and evolution of the mainly island salt-plugs (V7). The third (V6) contains a description of the subsurface geology and that of the overlying Tertiary rocks, so well exposed in west of the UAE. There is a detailed description of the extensive inland cover of dune-sand and the deposits of the barrier-islands, lagoons and coastal plain. This includes a discussion of their contentious Quaternary evolution (see Stevens *et al.*, 2014) using abundant OSL and U-Pb zircon dates.

The availability and future potential of various economic deposits, excluding oil, is discussed in vols. 3, 9, 10 and 11. The limestone resources, particularly dimension stone (widely used but mainly imported - V11), building aggregate, armour stone for harbour and coastal defences, rock wool and rock for tile manufacture as well as other construction materials are also considered (V10). Surprisingly, there is a lack of high quality silica-sand in this desert area due to impurities and unsuitable grain size of the dune-sand.

The occurrence of various economic mineral deposits (copper, chromite, platinum minerals etc.) in the ophiolitic rocks of the Hajar mountains are described (Vs 3,8) although these are not thought to be economic at present. There is a review of the hydrogeology (V3) although this is relatively unimportant, except in local areas of agriculture, as the major part of the water consumed is produced by desalination of seawater.

The geohazards of the region are discussed in V4 including the plate-tectonic setting of the surrounding area and its history of its seismic tremors and tsunamis. It is concluded that the UAE is

a low risk area. The other geohazards of the mountain front (rock falls, rock slides); alluvial fans (mainly flash-floods); the desert (dust and blown sand) as well as those of the coastal plain (aggressive ground water, liquefaction and variable strengths of sediments) are also considered.

Surprisingly there is no discussion of likely future problems posed by sea-level rise in a country whose major developments occur on a low coastal plain only a few metres above high water mark.

Various volumes (Vs 1, 5 & 12) of appendices and of executive summaries and others give further details of the geology and geophysics of particular areas and the sedimentology and palaeontology of some of the rocks of the Hajar mountains.

The volumes are all beautifully illustrated with abundant figures and photographs and a useful bibliography. The series will undoubtedly be extremely useful to geologists, engineers and planners.

Reviewed by **Graham Evans**

References - 1) Stevens, T., Jestico, M.J., Evans, G., Kirkham, A., 2014. Eustatic control of late Quaternary sea-level change in the Arabian/Persian Gulf. *Quaternary Research* 82, 175-184.

THE GEOLOGY AND GEOPHYSICS OF THE UNITED ARAB EMIRATES

(12 Volumes by various authors and of various dates 2006 - 2012). Ministry of Energy, United Arab Emirates.
List price: See website
www.bgs.ac.uk/research/international/UAE.html

Mining in Cornwall and Devon - Mines and Men



This work is the result of over 40 years' research into mine production data from the mines of Cornwall and Devon. Mostly gained from Parliamentary Papers and other official nineteenth century sources. The task of gathering the data was first started in the mid-1970s using the technology of the time to sort and store the vast amounts of

information. With state-of-the-art technology now available, a decision was made to publish this information.

At first, offering the data on-line was considered - but the route eventually chosen was to introduce the subject with a book accompanied by a CD of all the data to date. The book contains over 70 pages of tabulated figures in addition to the data that can be accessed on the CD. The statistics date from 1790 to the present day and have been gathered from some very obscure sources. The information presented not only details what the mines produced, who owned and managed them but also how many men, women and children were employed.

Not surprisingly, most data relates to metalliferous mining, but stone and clay quarrying and coal mining are also included. A useful section is the inclusion of biographical notes relating to Mine Managers, in addition to a bibliography of mine-related books and articles. The latter is not comprehensive but gives the researcher a starting-point for further investigations. The book is illustrated with 15 photographs, mostly relatively modern. These break up the text, but their quality is not as high as some other books on mining in the south west - possibly because of the quality of paper used.

There are some useful appendices such as the financial state of the mines over time and the costs of materials and labour in relation to them and in particular the section relating to mining companies and their personnel. The biographical details relating to mine managers will be of interest to historians. The final section of the book relates to the CD and is in effect a 'user manual'.

This book will probably become a standard reference for the economic and social history of the mines of Cornwall and Devon, as a supplement to already-published works that relate to the geological and technical aspects of this fascinating area of study.

Reviewed by **Richard Porter**

MINING IN CORNWALL AND DEVON: MINES AND MEN

by BURT R, with BURNLEY R, GILL M and NEILL A. 2014
Published by University of Exeter Press.
ISBN 978 0 85989 889 8. 251pp.
List price: £25.00



Quaternary Sea-Level Changes



Sea-levels have changed substantially over the last two million years on both a global and a local scale, and now global warming predicts that there are likely to be significant rises in the relatively near future.

Flooding caused by such changes has the potential to directly affect the lives of more than one billion people in coastal areas worldwide and with more people moving to coastal cities the situation is only going to get worse. An understanding of both the natural and anthropogenic processes that cause such changes is important in refining these predictions so that appropriate action may be taken.

Sea-levels can change by a number of different factors: the volume of water in the oceans can alter; or its temperature can rise or fall causing expansion or contraction; or there can be a change in level of the land caused by isostasy, or volcanic, seismic and tectonic forces. It's all relative! As geologists we know that such changes have been going on throughout the history of planet Earth although until the application of scientific principles such phenomena were given mythological or religious explanations.

This review by two Australian academics into the history of research on a world-wide basis summarises the analytical methods used to interpret the variety of evidence about sea-level changes. It covers the early examples that were explained in terms of the anger of the gods and then logically and symptomatically covers the evolution of ideas that has generated our present understanding. There are also 78 pages of references - a truly magnificent collection for those engaged in research in this area!

Over the past two or three decades a series of threats to life on Earth has been revealed, showing that we do not live in a stable unchanging situation with perhaps sea-level rise being one of the most important, with its implications for moving populations and for food and water resources. There seem to be two main problems; first, there is not full agreement between scientists working in this field, particularly on the amount and timing of the changes; and second, the political systems in at least the democratic

countries of the world are predicated on both short-term actions and national interest to win votes. It is hoped that this well written and readable textbook will help make a significant contribution by advancing knowledge - or am I being too optimistic?

Reviewed by **Rick Brassington**

QUATERNARY SEA-LEVEL CHANGES: A GLOBAL PERSPECTIVE

by COLIN V. MURRAY-WALLACE & COLIN D. WOODROFFE 2014. Published by: Cambridge University Press 484 pp (hbk) ISBN: 978-0-521-82083-7.
List price: £80.00 (US \$125.00) www.cambridge.org

A Photographic Guide to Shetland's Geology



This book is intended for the non-specialist visitor to Shetland who wishes to learn something of the geology of the archipelago. Following a basic introduction and summary of

Shetland's plate tectonic history there is a brief comment on Geopark Shetland which has developed an ingenious app linked to GPS to provide visitors with geological information on their mobiles when they arrive at a location of interest.

The core of the book is divided into sections based on rock types each accompanied by illustrative photographs. There is a section on the Shetland ophiolite, one on landscape, another on rocks, minerals and man and a final section unimaginatively labelled miscellaneous rocks, which deals with diagenesis, weathering and the colouration of rocks by algae and lichens. There is a two page glossary of geological terms, and maps showing the location of the photographs.

So, does the book fulfil its stated purpose? Only partly, I think. A field trip guide might have been a better approach. Many of the colour photographs are very good, particularly those showing cliff sections, but there are too many photographs of beach boulders and pebbles which frankly are rather unappealing. The captions are generally clear, concise, informative and entertaining.

The problem is how the visitor is expected to use this book. It is all very well to illustrate the difference between a basalt and an andesite, but to see them both the visitor might have to trek for miles. I suspect that the authors had in mind the casual visitor walking along a beach and finding an interesting-looking rock which he wants to identify, in which case the book would probably be helpful.

Shetland has some stunning coastal scenery and one might reasonably expect to see photographs of some of the best examples, rather than pictures of a gravelly bank which opens the landscape section, or four pages showing rocks covered with algae and lichen, or of one showing the difference between wet and dry pebbles. A few well-chosen aerial views would have been preferable.

On the whole a rather disappointing book, at a rather inflated price, but which includes a contribution to Geopark Shetland. I suspect one might do better to download the app, and use that.

Reviewed by **Don Hallett**

A PHOTOGRAPHIC GUIDE TO SHETLAND'S GEOLOGY

by DAVID MALCOLM and ROBINA R BARTON, 2015. Published by: The Shetland Times Ltd, 118pp (sbk) ISBN: 978-1-904746-97-3.
List price: £15.99. www.shetlandtimes.co.uk

BOOKS Available for review

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 a full up-to-date list at www.geolsoc.org.uk/reviews

- ◆ **NEW! Groundbreakers - the story of oilfield technology and the people who made it happen**, by Mark Mau and Henry Edmundson. Fastprint Publishing 2015, 462pp sbk.
- ◆ **NEW! Glaciers - the politics of ice**, by Jorge Daniel Taillant. Oxford University Press 2015. hbk, 334pp.
- ◆ **NEW! Geomorphology of Central America - a synergistic perspective** by Jean-Pierre Bergoeing. Elsevier 2015. 162pp, sbk.
- ◆ **NEW! Geofluids - developments in microthermometry, spectroscopy, thermodynamics and stable isotopes**, by Vratislav Hurai et al. Elsevier, 489pp, sbk.2015.
- ◆ **NEW! Extraterrestrial Seismology**, by Vincent Tong and Rafael Garcia (Eds). Cambridge UP, 2015. 441pp, hbk.
- ◆ **The Role of Volatiles in the Genesis, Evolution and Eruption of Arc Magmas**, by G F Zellmer et al., (eds). Geological Society of London Special Publication 410.2015292pp, hbk.

PEOPLE NEWS

CAROUSEL

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

◆ Colin Summerhayes



Colin Summerhayes has been appointed an Erskine Fellow of the University of Canterbury,

Christchurch, NZ, for the summer season 2015-16. Colin's book *Earth's Climate Evolution*, giving the geological perspective on climate change, will be published by WILEY/Blackwell in August 2015 (20% discount with promotion code 'EES14'). His lecture on that topic - to Imperial College's Grantham Institute, can be seen on YouTube at <https://www.youtube.com/watch?v=g0pgrzGnpv0&spfreload=10>

IN MEMORIAM

WWW.GEOLSOC.ORG.UK/OBITUARIES

THE SOCIETY NOTES WITH SADNESS THE PASSING OF:

Barker, R W N * McNicholas, J B *
Grinly, David *

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.



Golden finish

Edmund Nickless has lunch with Ted Nield and muses on changes since his appointment, the Glorious Revolution of 1997, and the future...



Edmund Nickless through the ages

We sat in Edmund's regular corner at the King's Head, and ordered fish and chips. The waitress retreated, with her instructions. Edmund's fish was to come with garden peas, should not be overcooked and should arrive 'with a golden finish' – not cremated and borderline inedible (like last time). Edmund is - particular. He likes it the way he likes it. With a golden finish. Cheese to follow. And no mushy peas, mashed potato or egg, thank you very much.

Like the waiting staff at the King's Head, we have got used to Edmund, who has managed and represented the Society – for some, even embodied it, which disquiets him a little – for the last 18 years. In that time, the Fellowship has almost doubled and the Society and Burlington House have been transformed.

It all began in 1997. "As I recall, there was an advertisement in *Geoscientist*. Robin Cocks, then Vice-President, was

overseeing the process. So, having known him for some time, I rang and asked if there was any point applying. He encouraged me. I wrote an application letter with CV; there was a shortlisting process and four of us were asked to talk to Council (at one of its regular meetings). I was also interviewed by senior staff."

That was an occasion I also recall, as it was where Edmund and I met (though as with the other candidates, all CGeols, not for the first time). "Mike Collins, then Director of Publishing, had been asked to report back. I think this was interesting because the staff were fully engaged in the selection process." Mike took back our unanimous recommendation (yes, it was Edmund!).

Staff did value their involvement – which was a far cry from the way his would-be successors were smuggled in and out of the building to interview with

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



a small 'appointment committee'. (Our swanky recruitment consultants forgot, however, to put blankets over the candidates' heads. The security monitors, and the Council Room's paper-thin walls, defeated this risible secretiveness.)

Odd

"I found many odd things. A 'Fellows' Bedroom' in the basement, where those staying overnight were disturbed by early morning deliveries. That we had two resident housekeepers, who didn't relish these uninvited guests. That Norma Barton provided daily tea for staff in the Lower Library, and coffee in the afternoon, and washed up the cups. That the limit on how many meetings we could hold was her capacity to make enough sandwiches.

"And a noticeboard - allegedly showing the remorseless growth of the fellowship across the ages. It was not very accurate, I discovered, because we never recorded any strikings off - the Society consistently overstated its membership. There were also 'Associated Fellows', who paid a reduced 'introductory' fee, on the understanding that they would convert to full Fellowship later - which of course they never did, and went on getting all the benefits at the lower price!

"The dispensing machine for miniatures, at 2/6d a pop, which had once graced the Fellows' Room and which you discovered under the stairs ... was a token, I feel, of the Society's being then rather like an exclusive gentlemen's club - not very welcoming or open, superior; still preserving the mystique of the Dining Club - where everyone suspected that everything was done! (And it did have some power. I remember a note, from Perce Allen to Kingsley Dunham: 'We had a word at the Club - I may have just the chap for you...')

Networking

"In times past, students were influenced by their teachers. They were basically told to join and, fearing it might do them little good to refuse, they did! Now, people join if they think the Society delivers something they want - basically, networking. It's 'making geologists acquainted with one another'.

"Another thing that has changed is the balance between academic and industrial. Academics now make up less than a quarter of the Fellowship, but were dominant in the past. This goes hand-in-hand with the move towards professional validation. The title has meaning in the professional world, and it has brought us new members who, before, might not have remained.

"This is valuable; in terms of impressing government, it's not so much our 'elite' quality that matters but the fact that all sectors are represented; being able to draw on a wide group, industrial and academic, from a diverse set of backgrounds and perspectives, able to input to policy development. Increasing diversity has worked in our favour because it gives us legitimacy.

“THE DISPENSING MACHINE FOR MINIATURES AT 2/6D A POP, WHICH HAD ONCE GRACED THE FELLOWS' ROOM AND WHICH YOU DISCOVERED UNDER THE STAIRS WAS A TOKEN OF THE SOCIETY'S BEING RATHER LIKE AN EXCLUSIVE GENTLEMEN'S CLUB...”

"Another debate going on in 1997 was the role of staff vis-à-vis Council. The concern was that if you employed staff who were competent in their professions, with experience and authority, this would be a 'challenge' to Council. But I saw that in the same light as the relationship of civil servants to ministers. Council oversees and directs; staff advise and execute. Many were still thinking in outmoded ways.

Occupancy

"Uncertainty about our tenancy [of Burlington House] had led to 'planning blight'. For years we had spent no money on the building, which was in a pretty pitiful state. But after 2005, with security of tenure established for up to 80 years, we were able to go ahead with restoring the interior to its current splendour, in time for the Bicentenary in 2007. We celebrated in style, redressing the lack of

activity of previous years and attracting sponsorship - not least, so that we could digitise almost everything that the Society has ever published and make it available online.

"We thought then that the lease was settled; but there remained the little matter of rent 'reviews'. Looking ahead, the formula for recalculating rent (based on property and rental values in the area) could now land the Courtyard societies with large increases. The rent we pay currently is extremely modest. But the escalation of property and rental values in Mayfair ... suggests that it could quickly become unaffordable. This problem is not likely to be resolved soon.

"Although the spirit of the agreement was that rent should remain 'affordable', this was not written into the agreement; and rather like the minutes of a meeting, what is written matters more than what was said.

"So the lease is currently 'held over', and while we remain in arbitration, everything is stuck. All we can do is assume the worst and begin to think once again about the cost of staying in Burlington House, and what we should do if this should prove to be 'too much'. We go back to the question: 'How important to the Society is being in Burlington House?'. Over the next decade there will need to be a serious debate about our attachment to bricks and mortar, to distinguish that, where necessary, from what is essential to doing what we do.

Roses

"Someone said something to me recently which I found deeply depressing, and that was: 'I suppose you (meaning the Society) will now retreat, and become inward-looking again' - as though all the international and multilateral activity during my tenure were a 'blip'. They assumed - feared - that this was just 'my' way, and that somehow the 'default' position would now resume.

"But of course it isn't like that at all. I am only a player, who has tried to make things happen. The future doesn't depend on me, and it will be different. But I am sure we shall not retreat.

"And now it's time to hand it back. I have enjoyed doing it. The roses may be calling, but I still have a few things to do first!"

DISTANT THUNDER

*The wasting of time***Geologist and science writer Nina Morgan* has stumbled over a curious case of research resurrection**

Visitors to Wytham Woods near Oxford may be startled to come across a group of standard-issue war-grave headstones standing in middle of a field. However, rather than commemorating the 'Glorious Dead', this 'cemetery' forms the basis of an experiment in rock weathering. The headstones, made of Upper Jurassic Portland limestone, carry no inscriptions and were surplus to the requirements of the War Graves Commission. Now equipped with sophisticated monitoring devices they are being used in project run by the School of Geography and the Environment at Oxford University to study stone decay, a topic of vital interest in the conservation and building stone industry.

Geikie

The Oxford study – one of several investigations that take

advantage of gravestones to study weathering in building stones – draws on a methodology first proposed in the 1880s by geologist Archibald Geikie (1835-1924). Geikie, son of a musician and music critic, began his geological career in 1885 as a surveyor in the Scottish branch of the Geological Survey. In 1860 he went on to work with Roderick Murchison (1792-1871), then Director of the Geological Survey, on a geological reconnaissance of the north-west highlands of Scotland.

Geikie eventually rose through the ranks to become Director General of the Geological Survey of Great Britain himself, in 1882 – until his retirement in 1901. In 1913, he moved to Haslemere, Surrey where he served as Chairman of the Haslemere Educational Museum from 1914 until his death in 1924.

Carboniferous

During his lifetime Geikie was recognised in geological circles for his studies of the Carboniferous and Permian volcanic rocks of Scotland. However, to the public at large he was perhaps best known for his readable and popular books about geology. A review of the

second edition of his *Scenery of Scotland*, which appeared in *The Spectator* in 1888, praised his writing skills above his scientific talent:

"Dr Geikie is perhaps the most agreeable writer on geology now left to us. When his Scenery of Scotland originally appeared, in 1865, it had a distinct success, less perhaps in virtue of the scientific theory it expressed and exemplified, than of its picturesque descriptions, in which the ring of the geologist's hammer had the accent of poetry, somewhat perhaps as the drone of the bagpipe is positively musical when heard a sufficient number of miles off."

But along with the scenery, Geikie also described a simple method for monitoring and studying weathering in building stones, noting, in Chapter 2:

"Nowhere can the nature of weathering be more conveniently and instructively studied than upon ancient masonry, and notably among the gravestones of a churchyard. Originally as they left the hands of the mason, the stones of a wall or slabs and pillars of a monument were smoothly dressed, or even polished. We can, therefore, compare their present with their original condition, and mark the nature and amount of the disintegration they have suffered."

Moreover, when the dates of their erection are preserved, we obtain from them a measure of the rate of waste."

Unlike many good ideas, this one hasn't died a death. In technology terms, its 'operating system' has simply been updated!

Acknowledgement

Sources for this vignette include 1885 edition of *The Scenery of Scotland* by Archibald Geikie available for download at

<https://archive.org/details/sceneryscotland01geikgoog>;

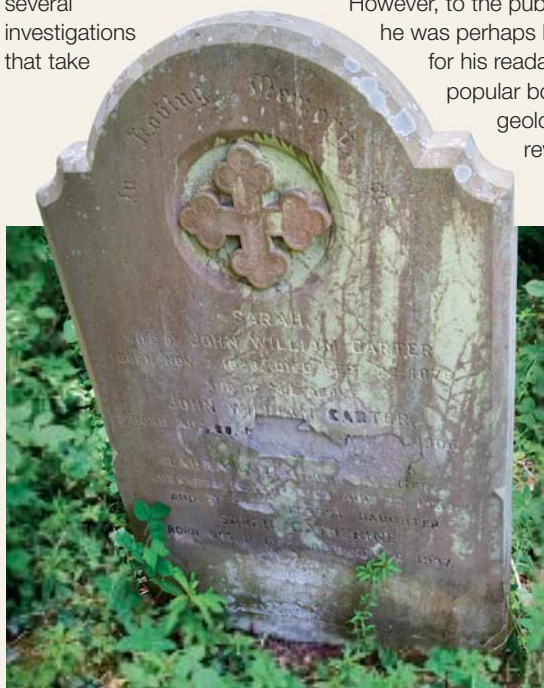
A leaflet about Geikie downloadable from

www.haslemere-museum.co.uk;

Conservation of Historic Graveyards, a guide for practitioners, published by Historic Scotland (ISBN 1 900168 74 X); and the Dictionary of National Biography entry for Sir Archibald Geikie by David Oldroyd. For information about the gravestone weathering projects carried out by a number of research groups in the UK see:

<http://www.scottishgraveyardds.org.uk/resources9.shtml>

***Nina Morgan** Morgan is a geologist and science writer based near Oxford. Her latest book, *The Geology of Oxford Gravestones*, is available via www.gravestonegeology.uk. A review will appear next month.



Weathering in a Pennant Sandstone gravestone erected in 1876 in Holywell Cemetery, Oxford



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OBITUARY

DESMOND HENRY OSWALD 1923-2015

Desmond Henry Oswald was born to the Rev. Herbert E and Constance Oswald, in Dublin, Ireland, and lived at the vicarage of Rathcore in Mullingar.

Idyllic

He spent an idyllic childhood on a large estate, keeping his sister Dorothy company while his brothers were away at school. Their father, the local vicar, also farmed - so Desmond grew up to love the church and spent much time in the fields. He loved animals and had many pets: a bullock, two cats, an angora rabbit and his favourite jackdaw, Jackie, who used to sit on his shoulder.

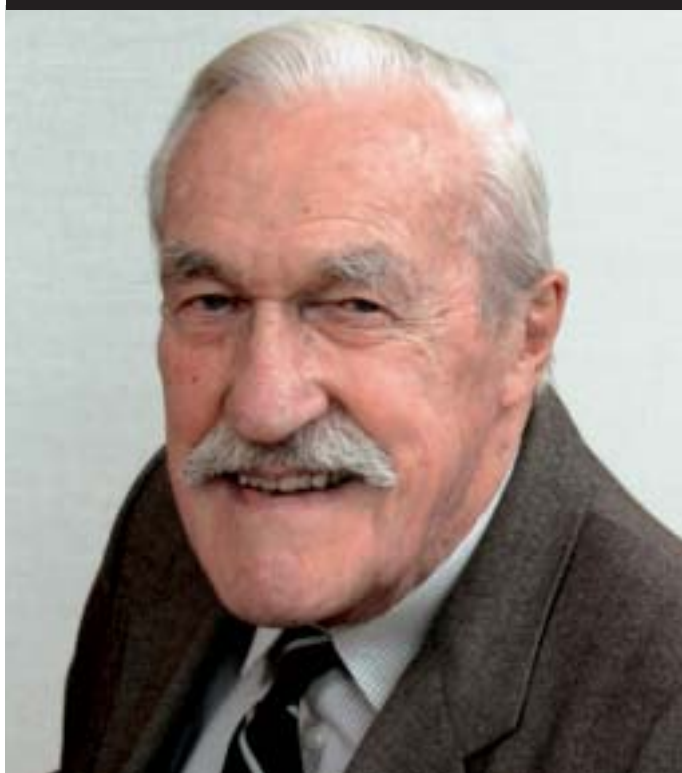
As a teenager he boarded at Campbell College Belfast. Graduating in war time, having been at a military school he was well equipped to become an officer in the Royal Corps of Signals. He came to England and served in East Africa.

In 1947 he was accepted at Corpus Christi College, Oxford, and discovering geology more to his liking than forestry, left with First Class Honours. From Oxford he went to lecture and study for a PhD at Glasgow University, later lecturing at Trinity College, Dublin. He was elected Fellow of the Society in April 1949, and latterly became known as a convivial member of its Dining Club.

Head-hunted

After only a few years he was head-hunted by Chevron Oil Corporation. Desmond loved

Exploration geologist who gained national notoriety over plans to drill for oil under Windsor Castle



“ HE TRAVELLED A GREAT DEAL, SPEAKING SEVERAL LANGUAGES – ADDING SWAHILI, ITALIAN, FARSI AND RUSSIAN TO HIS FRENCH AND GERMAN ”

Canada, in the summer leading groups on field trips to northern Alberta. Living in Calgary, he made many contacts and met his future wife Ollive, who described seeing him surrounded by beautiful ladies and decided to set him up on a blind date

with her best friend. But it was not her friend who interested him!

They married and soon had a daughter, Maureen. From Canada Desmond was promoted to a job in Tripoli, Libya, where his second child, Desmond Jr., was born. Three years later, on January 4, his youngest daughter Deirdre was born. Ollive and Desmond spent many happy years in Libya, where he pastored at the local church and spent time at the Embassy with local expats. Desmond had a great ability to put others at ease, and throughout his life made many friends.

Soon the family returned to

Calgary, where they spent a short time before being re-located to Tehran. His time cut short by revolution, Desmond returned to England. After a stint in Holland the family finally settled, first in London, then Gerrards Cross, handy for Heathrow and Head Office. As an expert in Middle East geology he travelled a great deal, speaking several languages – adding Swahili, Italian, Farsi, and Russian to the French and German he learnt at school.

Media coverage

After 40 years at Chevron he retired and joined Reading University. He remained semi-retired until his death, still sought out for his expertise, working on projects in Italy and Southern England - including the infamous 'oil reserve' under Windsor Castle, which gained him nationwide media coverage.

A year ago he was diagnosed with cancer of the oesophagus. He remained courageous and met the news with strength and peace. Still mentally and physically active, he enjoyed meetings at the Geological Society and kept up with the snooker, tennis, rugby and world affairs. He travelled to Ireland in the summer and remained positive, fighting to the end.

He lived an illustrious and full life, was loved by many and will be missed by many friends and loved ones.

► By **Ted Nield**, from a eulogy by Deirdre Oswald

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.

DIARY OF MEETINGS EVENTS 2015

COURSE	DATE	VENUE AND DETAILS
William Smith Meeting GA Dorset Group Wessex Cephalopod Group Wm Smith Bicentenary	30 September- 03 October	Venue: Sherborne Castle. Field Trip, Lecture, Evening Meeting. See website for details
Ineson & Darcy Lectures IAH, Hydrogeological Group	05 October	Venue: Burlington House, London. 09.30-19.00. See website for details. Fees (discounts) apply. Contact: Brigid O Dochartaigh E: beod@bgs.ac.uk.
Petroleum Geology of the Black Sea Petroleum Group	06 – 07 October	Venue: Burlington House. See website for fees, discounts and booking. Contact: Laura Griffiths E: laura.griffiths@geolsoc.org.uk
Visualising Landscapes & Geology, Past, Present & Future Wm Smith Bicentenary	07-28 October	Venue: Wills Bldg., University of Bristol. Lecture series. See website for speakers and details. Contact: Claudia Hildebrandt E: c.hildebrandt@bristol.ac.uk or Dr Lisa Hill E: Lisa.Hill@bristol.ac.uk
Poetry reading National Museum of Wales/National Poetry Day/Wm Smith Bicentenary	08 October	Venue: National Museum of Wales, Cathays Park, Cardiff. See website for details. Contact: Michael McKimm E: michael.mckimm@geolsoc.org.uk
Sidmouth Science Festival Earth Science Week	09-18 October	Venue: Sidmouth (various venues). See website for details and links. Contact: Sidmouth Science Festival W: www.sidmouthsciencefestival.org/festival.aspx E: info@sidmouthsciencefestival.org
Earth Science Week at Heysham Library	10-18 October	Venue: NWH Geopark. Field Trip, lecture, social event. Times – various. Walks – £4.00. Rest free. See website for details. Contact: Laura Hamlet E: laura@nwhgeopark.com
Family Festival of Science Thos. Hardy School/Earth Science Week	10 October	Venue: Thos. Hardy School, Dorchester, Dorset. Time: 1300-1700. Free. See website for details.
West Sussex Geology: Exploring Building Stones in West Sussex W. Sussex Geology/Earth Science Week	11 October	Field trip & social event. Time & Venue: 11.30 at St Peter's Church, Westhampnett. Finish around 16.30. Cost: £5.00. See Website for details. Contact: David Bone E: david@dajbone@plus.com
William Smith goes to school! Earth Science Week 2015/Northumbria University/William Smith Bicentenary	12-16 October	Workshop. Venue: 10 schools across Northumbria. See website for details. Contact: Matthew Pound E: matthew.pound@northumbria.ac.uk
Durham Cathedral – Mud Monsters Durham Cathedral/Earth Science Week 2015/Year of Mud	12-16 October	Workshop, social event. Venue: Durham Cathedral. Cost £3.00 per child. Contact: Pam Stewart E: pam.stewart@durhamcathedral.co.uk W: www.durhamcathedral.co.uk/whatson
Geological Repositories: Technology and High Technology Transfer Conference Geological Repository Network	12-15 October	Conference. Venue: Edinburgh. See website for details. Contact: E: info@georepnet.org. W: www.georepnet.org/
Imagining Life on Earth Yorks. Phil. Soc./ Earth Science Week 2015	13 October	Lecture. Time: 19.30. Venue: Tempest Anderson Hall. Speaker: Prof. Phil Manning, University of Manchester. Contact: E: info@ypsYork.org W: www.ypsYork.org.
European Shale Gas and Oil Summit ESGOS	15-16 October	Conference, workshop. Venue: Central Manchester. See website for details. Contact: Zuzanna Marchant E: zuzanna.marchant@charlesmaxwell.co.uk. W: www.esgos.eu/
The Age of the British Isles: Come on a date with UCL Earth Sciences! UCL Earth Sciences/Earth Science Week 2015	16 October	Social event, workshop. Venue: UCL Earth Sciences Rock Room, 1st Floor, South Wing, UCL Main Site, London. See website for details. Time: 13.00-16.30. Contact: Ruth Siddall E: r.siddall@ucl.ac.uk.
ProGeo 2015 South West Regional	16 October	Conference: 'Emerging Technologies in the Geosciences'. Venue: Kenn Centre, Exeter Rd., Devon EX6 7UE. See website for details. Contact: Jonathan King at E: southwestrg@gmail.com
Geowalk: War memorials and embassies: The building stones of Mayfair Earth Science Week 2015/ London Walks	18 October	Field trip, social event. Venue: Green Park Station Park Exit. Time: 10.45. Cost: £5.00. See website for details. Contact: Ruth Siddall E: r.siddall@ucl.ac.uk

OBITUARY

MICHAEL COOPER 1949-2015

In professional terms Mike Cooper is best described as a Civil Engineer who had a passion for geology. He was as enthusiastic describing the complexities of geology and its impacts for structural engineers as he was teaching engineering geologists the finer points of soil mechanics. During his 44-year career he worked with contractors, public engineers, universities and consultants. He joked that he pursued a career in geotechnics because that was the subject he struggled with during his first degree, and he always liked a challenge.

Lectureship

After working for specialist contractors Soil Mechanics and West Yorkshire County Materials Laboratory, Mike took on a lectureship at the University of Southampton. The move to academia presented new possibilities, including a six-month secondment to the Norwegian Geotechnical Institute, starting a connection to Norway that continued throughout his career.

After this experience Mike wanted more industrial engagement, so persuaded the University to enable him to take up a part-time secondment to consultants Gifford. His talent for identifying key ground related risks based on the geological characteristics of a site, making these real to his colleagues, and then

Engineer and enthusiastic geologist who always stressed the importance of ground conditions



producing innovative design solutions made him an invaluable part of the Gifford team.

“MIKE WAS REGULARLY IDENTIFIED AS A FAVOURITE LECTURER AND TUTOR BY COLLEAGUES”

After a 19-year association with the University, he moved full-time to Gifford. His impact, while at the University was substantial and more than a decade later Mike was

regularly identified as a favourite lecturer and tutor by colleagues and clients alike. This shows the passion that Mike brought to the marriage of geology and engineering disciplines, and he carried this forward as a trusted teacher and mentor of the growing team at Gifford.

Managing risk

Mike never forgot his roots as a technical specialist and that his main function was to advise clients and colleagues on the best ways to manage ground-related risk. He also brought a sense of enjoyment into the team, and always managed to mentor others,

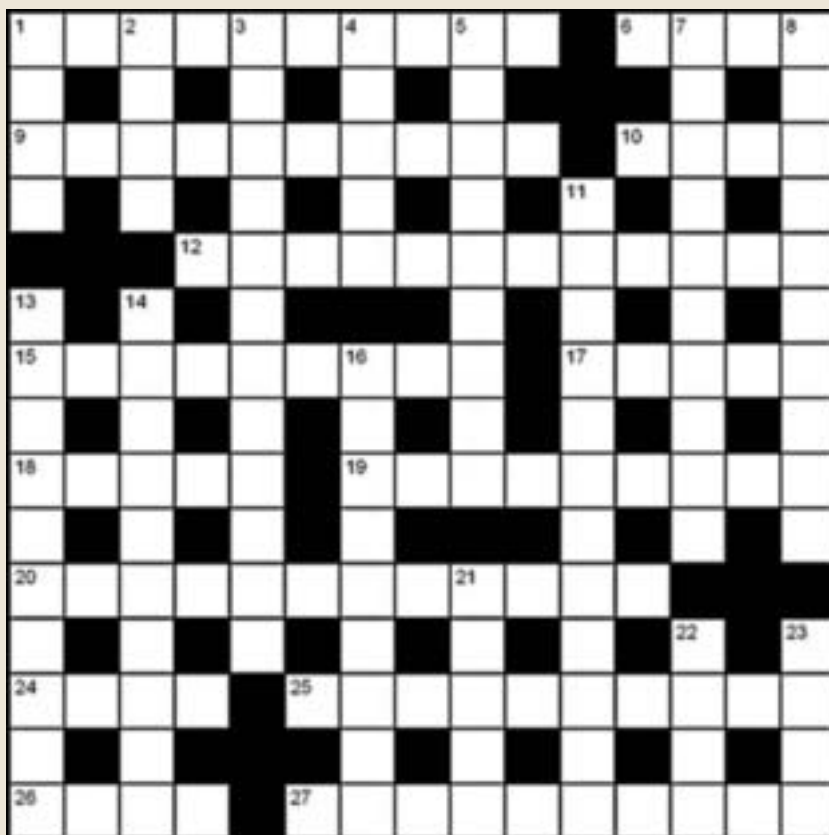
no matter how busy he was. Eighteen months after Gifford was acquired by Ramboll, Mike retired from full time consulting and split his time between the UK and Norway, assisting with project delivery and, most importantly, the development of ground engineering skills with both Ramboll teams.

Mike's project achievements are too numerous to list in detail; however in the CIRIA-sponsored Selbourne slope stability project, Mike used imagination and insight, leading to a BGS Prize Award-winning publication. In the Gibraltar East Water Catchments stabilisation programme Mike used innovation to protect householders at the base of a 300-metre high slope. Mike was also particularly proud of his achievements on the Gateshead Millennium Bridge and Second Severn Crossing.

Mike's professional legacy is a UK-based ground engineering team that numbers more than 50 engineering geologists and geotechnical engineers, based in five locations. Mike also played a key role in the establishment of the Southern Geotechnical Group in the 1990s and the successful Geological Society Solent Regional Group. Mike is survived by his wife Glynis, daughter Holly, and son Ashley.

► By **Stephen L West**

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.

CROSSWORD NO.196 SET BY PLATYPUS**ACROSS**

- 1** Twin whose twin plane changes the crystal shape rather like a knee-bend - as seen in rutile (10)
6 Mohs' softest (4)
9 Time, energy or matter expended in the hope of future benefit (10)
10 Sicilian edifice (4)
12 Happening together but in a non-causal relationship (12)
15 Single celled animal (9)
17 Two thirds, we're told (5)
18 Spiny angiosperms native to the Americas (5)
19 Sweet briar *Rosa rubiginosa* (9)
20 Defunct psychopathological term denoting fatigue, anxiety, depression, headache and palpitations (12)
24 Make a liquid muddy by disturbing sediment (4)
25 Authoritatively judge or decide between conflicting claims (10)
26 Long, ancient Scandinavian yarn (4)
27 The state of having power over another (10)

DOWN

- 1** Millstone, for example (4)
2 Mass of porous ice, formed from snow, that has not yet become frozen into glacier ice - firn (4)
3 Such species can be found growing or occurring in many parts of the world; widely distributed. (12)
4 SI unit of light flux (5)
5 Created by pulling-apart forces (9)
7 Quite the opposite (10)
8 First oceanographic research vessel 1872-76 (10)
11 Cursorily and perhaps hastily explored the surroundings (12)
13 Places on the Earth's surface directly above earthquake foci (10)
14 Brigrining to a close
16 Places the youngest on the bottom and the oldest on top (9)
21 Omit certain sounds in a word or phrase (5)
22 Its playing fields have made us all frightfully brave (4)
23 Seagirt, and possibly scept'r'd, depending on whose opinion you take. (4)

WIN A SPECIAL PUBLICATION!

The winner of the August Crossword puzzle prize draw was **Richard Smout of Aboyne**.

All correct solutions will be placed in the draw, and the winner's name printed in the December/January 2016. The Editor's decision is final and no correspondence will be entered into.

Closing date - October 27.

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

Membership number

Address for correspondence

Postcode

SOLUTIONS AUGUST**ACROSS:**

1 Dimorphism **6** NERC **9** Nottingham **10** Etna
12 Coleopterans **15** Quarrymen **17** Learn
18 Asset **19** Reduction **20** Orthorhombic
24 INRI **25** Versailles **26** Lieu **27** Stockyards

DOWN:

1 Dune **2** Mote **3** Rhizocretion **4** Hague
5 Sharpened **7** Euthanasia **8** Coarsening
11 Reflectivity **13** Equatorial **14** Basseterre
16 Marshiest **21** Music **22** Slur **23** Isis



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Call for Abstracts – Deadline 31 October 2015

East Africa From Research to Reserves

13-15 April 2016
The Geological Society, Burlington House, Piccadilly, London




Recent exploration campaigns both on- and offshore East Africa have discovered a tremendous resource, which has propelled the region from being one of possibilities to one with commercial opportunities of significant scale. These discoveries are set to make East Africa a major energy resource player in the 21st Century, yet many challenges remain.


The meeting will bring together experts from industry and academia to present the latest data and research with submissions already received from Anadarko, BG Group, BP, Genel, ION, Total, Tullow, Schlumberger, Halliburton, with numerous Universities, Consultancies and Government Agencies. An excellent response was obtained to the first call for papers and only a few oral and poster slots remain.

Call for Abstracts:
Please email paper and poster abstract submissions to laura.griffiths@geolsoc.org.uk before 31 October 2015


Further information:
For further information, please visit the conference website at www.geolsoc.org.uk/East-Africa-From-Research-to-Reserves



At the forefront of petroleum geoscience
www.geolsoc.org.uk/petroleum



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The Geology of Geomechanics

28-29 October 2015

The Geological Society, Burlington House, London, UK

LAST CHANCE TO BOOK

This conference aims to bring together geologists and engineers from the petroleum, radioactive waste disposal, carbon sequestration, mining and geothermal communities to discuss the links between the geomechanical disciplines and mainstream geology.

We define geomechanics as the study of stresses in the crust, and their impact on the stability of rocks (e.g. reservoirs, seals, faults) and man-made features therein (tunnels, boreholes, repositories).

Stress leads to change and we need data, tools, models and workflows to understand and manage it. Geomechanics is a well-established sub-discipline but until recently has had relatively little airing across geology. However, geomechanical models depend critically on geological inputs. We are particularly interested in what geological observations can add to the predominantly present-day observations and analysis of geomechanics. Furthermore, what can geology learn from the unique observations of geomechanical datasets?

Field Trip to North Somerset Coast
Date: Friday 30 October - Sunday 1 November 2015

There will be a post-conference field trip to the North Somerset coast to examine the world class exposures of faults, fractures and inversion tectonics in the Triassic and lower Jurassic strata exposed on the massively extensive foreshore and cliffs. For more information, contact: jonathan.turner@bg-group.com

Keynote speakers
Dr Tony Addis (Baker Hughes)
Professor Terry Engelder (Pennsylvania State University)
Dr Julia Gale (University of Texas at Austin)
Professor Rick Sibson FRS (formerly University of Otago)
Dr Mark Tingay (Chevron)

Convenors
Jonathan Turner (BG Group)
Dave Healy (University of Aberdeen)
Richard Hillis (Deep Exploration Technologies CRC)
Michael Welch (Schlumberger)

Further information
For further information about the conference please contact:
Conference Office,
The Geological Society,
Burlington House, Piccadilly,
London W1J 0BG
T: 0207 434 9944
E: laura.griffiths@geolsoc.org.uk
W: www.geolsoc.org.uk/Geology-of-Geomechanics-15



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Puzzle of Earth's Uninterrupted Habitability

11 November 2015

Geological Society, Burlington House, London, UK





LAST CHANCE TO REGISTER


Confirmed Keynote Speakers:
Professor Tim Lenton (University of Exeter)
Professor Toby Tyrrell (University of Southampton)

Convenors:
David Waltham (Royal Holloway University of London)
Graham Shields (University College London)


For further information please contact:
Laura Griffiths, Conference Office,
The Geological Society,
Burlington House, Piccadilly,
London W1J 0BG
T: 0207 432 0983
E: laura.griffiths@geolsoc.org.uk
W: www.geolsoc.org.uk/puzzleofearth
@geolsoc, #puzzleofearth

Environmental conditions at the Earth's surface have been continuously suitable for life for more than three billion years. Temperatures, for example, have only varied by few tens of centigrade despite large changes in solar luminosity and atmospheric composition. Since the Archean, the planet has not once been rendered sterile.

However, the reasons for this long-term life-friendliness remain contentious. How has Earth's climate avoided the runaway warming shown on Venus or the runaway cooling of Mars? Has Earth's relative stability resulted from geochemical feedback (e.g. through silicate weathering), the stabilizing influence of a complex biosphere (i.e. the Gaia hypothesis), good luck (e.g. purely fortuitous cancellation of solar warming by decreased greenhouse gas concentrations) or is long-term life-friendliness simply the consequence of life's extraordinary adaptability (allowing it to survive even Snowball Earth events)?



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Geomechanical and Petrophysical Properties of Mudrocks

16-17 November 2015

The Geological Society, Burlington House, London

LAST CHANCE TO REGISTER

Confirmed Keynote Speakers include:
Julia Gale (University of Texas, USA)
Alexandra Amann-Hildenbrand (Aachen, Germany)
Peter Lee (University of Manchester, UK)
Jeff Wilson (James Hutton Institute, UK)
Andrew Applin (Durham University, UK)

Convenors:
Ernie Rutter (Manchester University)
Julian Mecklenburgh (Manchester University)
Zoe Shipton (Strathclyde University)
Kevin Taylor (Manchester University)


Follow this event on Twitter:
@geolsoc #propofmudrocks and #yearofmud

A surge of interest in the geomechanics and petrophysical properties of mudrocks (shales) has taken place in recent years following upon the development of a shale gas industry in the United States and with the prospect of similar developments in the UK and elsewhere. Compared to most other rock types, geomechanical and microstructural studies on mudstones are more demanding owing to their fine grain size, complex mineralogy and difficulties in handling. The need to develop an industry that is efficient and satisfies public concerns demands that the fullest possible understanding of the mechanical and petrophysical behaviour of these rocks be obtained and applied to engineering and environmental questions.

The scope of this meeting encompasses studies of strength and frictional behaviour, time-dependent creep, hydraulic fracture development, permeability, electrical conductivity and acoustic wave propagation.

Further information:
For further information about the conference please contact:
Laura Griffiths, Conference Office, The Geological Society,
Burlington House, Piccadilly, London W1J 0BG
T: 0207 432 0983
E: laura.griffiths@geolsoc.org.uk
W: www.geolsoc.org.uk/Geomechanical-and-Petrophysical-Properties-of-Mudrocks

William Smith Meeting 2015



LAST CHANCE TO BOOK

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PART OF THE WILLIAM SMITH MAP BICENTENARY PROGRAMME OF EVENTS

200 Years and Beyond: the Future of Geological Mapping

5 November 2015 The Geological Society, Burlington House, London

The first William Smith Meeting in April 2015 chronicles the history and development of the geological map from its earliest beginnings to the digital maps of today. This second William Smith Conference will look to the future of geological mapping, and will open with a keynote by Professor Iain Stewart on the grand challenges for geoscience that will motivate the 'William Smiths' of tomorrow. It will showcase the new science, technologies and information systems that are changing and broadening the whole concept, purpose and impact of geological mapping.

Themes and topics will include:

- What is 'geological mapping' in the modern age of digital information and geological models?
- What are the future demands for spatial geological data and knowledge? How will these vary across emerging and developing economies?
- What will the geological map of tomorrow look like? How will the digital revolution shape how we present, visualise and communicate geological knowledge?
- What new technologies are emerging in digital mapping, geophysics, earth observation and modelling? How do we integrate these with field-based geological observations and interpretation?
- What skills will be needed by the field geologists of the future? Do we still need to teach students how to map, and why?



Convenor:
Andy Howard (BGS)

Further Information

Laura Griffiths, Conference Office, The Geological Society, Burlington House, Piccadilly, London W1J 0BG
T: 0207 432 0983
E: laura.griffiths@geolsoc.org.uk
W: www.geolsoc.org.uk/wsmithNov15

Follow this event on Twitter: @geolsoc, #wsmith15, #williamsmith200

**The William Smith Map
Bicentenary (1815-2015)**

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Groundwater in Fractured Bedrock Environments: Managing Catchment and Subsurface Resources

10 June 2016 Queen's University, Belfast, Northern Ireland



Across the UK & Ireland, fractured bedrock aquifers have been traditionally regarded as low productivity aquifers, with only limited relevance to regional groundwater resources. But it has been increasingly recognised that these complex bedrock aquifers can play an important role in catchment management and subsurface energy systems.

In many scenarios, a robust understanding of fractured bedrock environments is required to assess the nature and extent of connectivity between such energy & storage systems at depth and overlying receptors in the shallow subsurface or above ground.






Convenors:
Dr. Ulrich Ofterdinger (Queen's University Belfast)
Prof. Alan MacDonald (BGS)
Dr. Jean-Christophe Comte (University of Aberdeen)
Mike Young (Geological Society)


Further information:
T: 020 7432 0983
E: laura.griffiths@geolsoc.org.uk
W: www.geolsoc.org.uk/fracturedbedrocks

Follow this event on Twitter: @geolsoc #fracturedbedrocks #yearofwater

Conference Focus:
This conference will focus on the role of fractured bedrock aquifers in catchment management and in managing subsurface resources.

Call for Abstracts:
We welcome oral and poster presentations for this conference. To be considered for a slot in the programme or a poster presentation, please send an abstract of no more than 400 words to Laura Griffiths, no later than Friday, 27 November 2015.



REGISTRATION IS NOW OPEN

The Geological Society Careers Days 2015

Wednesday 18 November 2015
Venue: BGS, Keyworth, Nottingham, UK

Wednesday 25 November 2015
Venue: Our Dynamic Earth, Edinburgh, UK

The Geological Society's Careers Days are the most recognised geological careers-based forum in the country; the essential meeting place for geoscience students and the industry leaders.

The day will include presentations on careers and an exhibition fair. Students will have the chance to find out about the latest career options and talk to industry leaders about how they may gain entry into that sector. There will also be some University representatives available to discuss MSc and PhD programmes.


Registration

The events are free to attend. Numbers are limited, so you will need to pre-register to attend.

To pre-register, please complete the paper registration form (available to download on the website) or send an email to Sarah Woodcock; state your name, university/affiliation and the careers day you would like to attend (18 November in Nottingham or 25 November in Edinburgh), no later than 30 October 2015.

Contact Information

Sarah Woodcock, The Geological Society, Burlington House, Piccadilly, London, W1J 0BG
T: 0207 432 0983
E: sarah.woodcock@geolsoc.org.uk
W: www.geolsoc.org.uk/careersdays15
@geolsoc #GSLcareers





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WILLIAM SMITH MAP PRINTS

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