

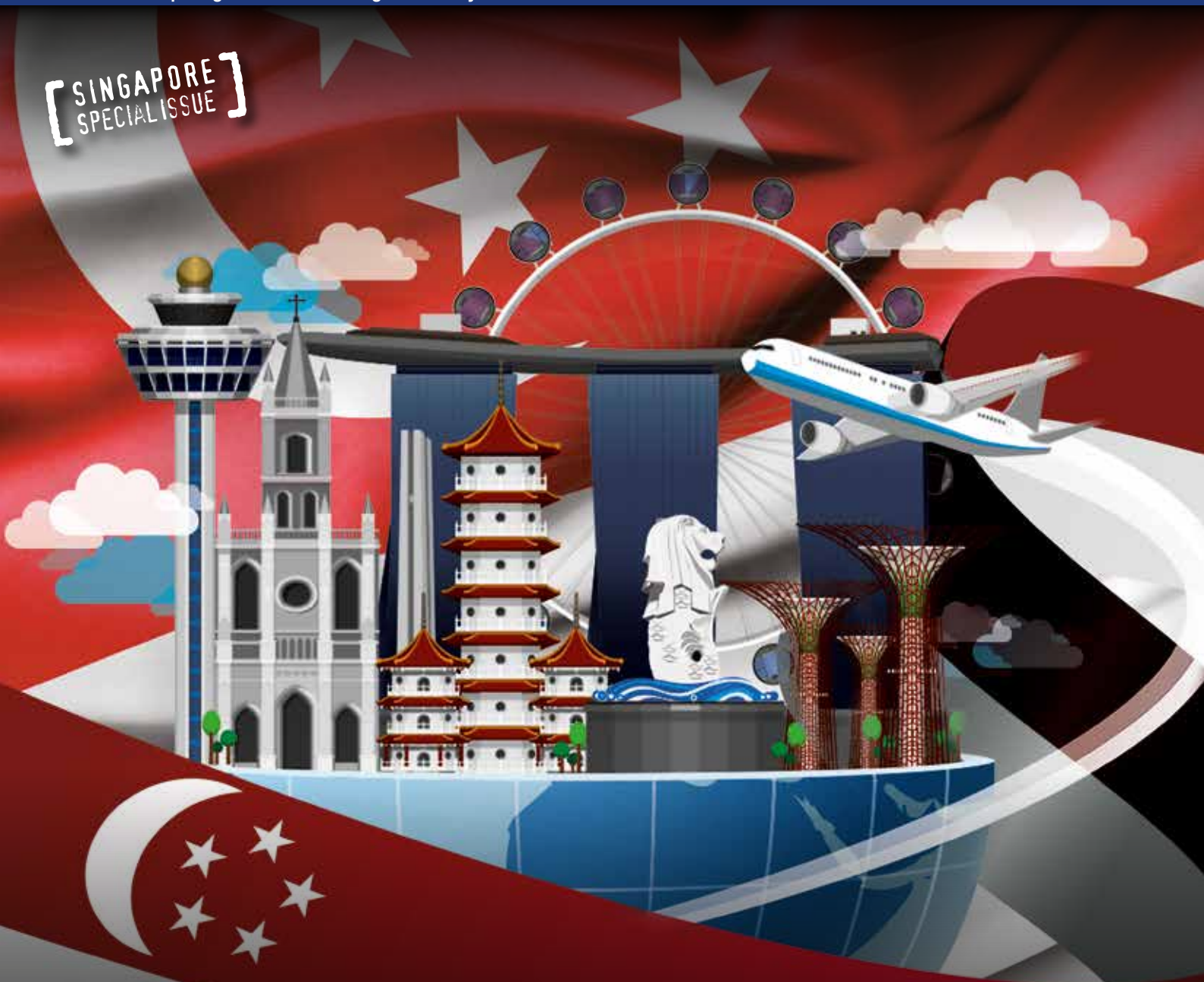
GEOSCIENTIST

VOLUME 27 NO 10 ♦ NOVEMBER 2017 ♦ WWW.GEOLSOC.ORG.UK/GEOSCIENTIST

The Fellowship Magazine of the Geological Society of London

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[SINGAPORE
SPECIAL ISSUE]



Hidden Tiger

Graham Leslie and Rhian Kendall
uncover the geology beneath Singapore

ELIZABETH ALEXANDER
Mary Harris on her mother's
pioneering work

TRUST & TRANSPARENCY
Mark Steeves on building
public confidence

COAL COMFORT?
Bryan Lovell and Ted Nield
on coal, CCS and Germany



BRYAN LOVELL MEETING 2017

Mining for the Future

23-24 November 2017

The Geological Society, Burlington House, London

Confirmed speakers to include

Daniel Franks
(UN Development Programme)
Richard Herrington
(Natural History Museum)
Kathryn Goodenough (BGS)
Sarah Gordon (Satarla Ltd)
David Manning (Newcastle University)

Convenors

Nic Bilham (Geological Society)
Edmund Nickless
(Geological Society / IUGS)
Andrew Bloodworth (BGS)
Frances Wall
(Camborne School of Mines)
Natalia Yakovleva
(Newcastle University)


Further information

For further information about the conference please contact:
Naomi Newbold, Conference Office,
The Geological Society,
Burlington House, Piccadilly,
London W1J 0BG

T: 0207 434 9944

E: naomi.newbold@geolsoc.org.uk

Web: www.geolsoc.org.uk/lovell17

 Follow this event on Twitter:
#lovell17

The mineral resource needs of the future will be different to those of the past and present. Delivering the UN 2030 Sustainable Development Agenda and implementing the COP 21 Paris Agreement to decarbonise the global economy will alter and add significantly to the demand for metals and minerals by both developed and developing countries. Our growing global population rightly expects greater prosperity and more equitable access to resources, and is becoming more industrialised and urbanised.

We are only beginning to understand the challenge of meeting these needs in a way which is environmentally, economically and socially sustainable. Meeting this challenge will depend on cutting-edge research across the geosciences and in other disciplines, including engineering, economics and social sciences – and will require engagement with industry, the financial community, policy-makers and the wider public.

Introducing our Year of Resources running throughout 2018, this meeting will bring together a wide community of geoscientists and others to explore how we can address this challenge, and start to develop a roadmap for this multidisciplinary effort.

It is held in conjunction with the IUGS Resourcing Future Generations initiative, and will inform the major IUGS conference on this topic to be held in Vancouver in June 2018.

Conference Themes

- Future Demand
- Where will future resources come from?
- Meeting the resource challenge responsibly
- Who do should we engage in this effort, and how?



Geoscientist is the Fellowship magazine of the Geological Society of London

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PRINTED BY

Century One Publishing Ltd.

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ISSN (print) 0961-5628
ISSN (online) 2045-1784

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Subscriptions: All correspondence relating to non-member subscriptions should be addressed to the Journals Subscription Department, Geological Society Publishing House, Unit 7, Brassmill Enterprise Centre, Brassmill Lane, Bath, BA1 3JN, UK. Tel: 01225 445046. Fax: 01225 442836. Email: sales@geolsoc.org.uk. The subscription price for Volume 27, 2017 (11 issues) to institutions and non-members will be £139 (UK) or £159/\$319 (Rest of World).

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Corporate Supporters:

Call for Abstracts – Deadline: 23 Feb 2018

Eastern Mediterranean – An emerging major petroleum province

29-30 May 2018
The Geological Society, Burlington House, Piccadilly, London

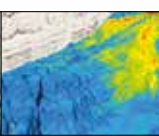




Image courtesy of Chevron Image courtesy of PGS

The objective of the conference is to enhance technical understanding of the status of key plays in this geologically complex region

In recent years the Eastern Mediterranean region has witnessed growing interest from international energy companies. Substantial gas reserves have been found in Egypt's Nile Delta Basin and in the Mediterranean coastal areas since 1995, and in more recent times Noble Energy has discovered a series of substantial gas fields off the Israeli coast. Several countries have been announcing licensing rounds in recent years.

A key objective of the meeting is to seek a strong set of papers to highlight in greater depth recent discoveries such as those of the prolific Pliocene Nile Delta province and the more recent ENI Zohr supergiant carbonate discovery and the successful clastic plays in the Levant Basin. Results from Totals current drilling campaign in Cyprus Blk 11 will also drive interest in the region.

The conference will review exploration activity, as well as challenges to a better understanding of the geology in the eastern Mediterranean, including seismic (and other data) acquisition and imaging. Key geological issues for understanding subsurface risk in the area will be addressed, including but not limited to

- Geodynamic Evolution
- Pre-salt plays including carbonate build-ups
- Source rock distribution and maturity
- The importance of regional seismic and refraction data
- Sediment provenance studies
- Reservoir quality and reservoir characterisation
- Potential of deeper plays and possibilities for oil.


Call for Abstracts:
Please submit abstract contribution to sarah.woodcock@geolsoc.org.uk by 23 Feb 2018.


For further information please contact:
Sarah Woodcock, The Geological Society, Burlington House, Piccadilly, London W1J 0BG. T: 020 7434 9944

Convenor:

Iain Brown
PGS


Event Sponsor:





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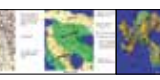
Corporate Supporters:

Call for Abstracts – Deadline 15 December 2017

Advances in Production Geoscience as an enabler for maximising economic recovery and ensuring a future for the UKCS

5-7 June 2018
Robert Gordon University, Aberdeen

Out of adversity comes opportunity. A significant change is required in the North Sea petroleum industry to keep it profitable and growing, and geoscience has the opportunity to lead the way in delivering this change. New plays, fields, technologies and alliances are required in order to increase recovery and reduce the cost of delivering hydrocarbons. In 2014 the Maximising Economic Recovery UK report suggested that 12-24bn barrels of oil equivalent remained to be produced from the North Sea. This conference aims to show how geoscience is helping to develop and recover as much of this remaining hydrocarbon as possible. It will showcase the range of solutions maximize economic recovery from the UKCS.

Specific themed sessions may include:

- Near Field Exploration
- New field developments
- Short radius sidetracks
- Infill drilling
- Production from secondary reservoirs
- The value of surveillance
- Existing infrastructure – hosts for new opportunities, making it last longer, novel maintenance, alternative uses (wind/CO₂ disposal)
- Shallow gas (fuel source) and water (for injection)
- Novel drilling technology as an enabler for difficult geology
- Exploiting difficult fluids
- Use of new technology or first application of technology to the UKCS
- Enhanced Oil and Gas recovery
- Adding value from co-produced fluids
- Decommissioning

The focus of the meeting will be on Geoscience, Reservoir Engineering and Petrophysics with the recognition that successful integration across the subsurface and surface disciplines is at the heart of a successful shift in future fate of the UKCS.

Call for Abstracts:
Please submit paper contribution to abstracts@geolsoc.org.uk and copied to caroline.gill@shell.com by 15 December 2017.

For further information please contact:
Sarah Woodcock, The Geological Society, Burlington House, Piccadilly, London W1J 0BG.
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Shell UK Limited

Matt Brettell
Statoil Production UK


Jon Gluyas
University of Durham

Cliff Lovelock
Shell UK Limited

John Underhill
Heriot Watt University


Confirmed Keynote Speaker:


Al Tucker
Brent Asset Manager,
Shell



At the forefront of petroleum geoscience

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FUGRO TECHNICAL COURSES

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8 th December 2017	Manchester
25 th January 2018	Glasgow
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8 th November 2017	Wallingford
Physical Hydrogeology course	
18 th October 2017	Fulham London

To apply for the **Cone Penetration Testing (CPT)** courses email to: s.poulter@fugro.com
To apply for the **Soil and Rock Logging and Physical Hydrogeology** book online at:
www.firststeps-geo.co.uk/course-calendar

“GERMANY’S SPENDING ON ENERGY R&D HAS STAGNATED FOR A DECADE AND, ACCORDING TO THE OECD, IS EXCEEDED IN THIS NIGGARDLY SHORT-SIGHTEDNESS ONLY BY – THE UK”

FROM THE EDITOR’S DESK:

Coal comfort?

Two reactions emerged from the editorial Coal is Dust (*Geoscientist* 27.5, June). One was that, elsewhere in the world, geologists are still helping to find and dig it (Letters, *Geoscientist* 27.8 September). The other was that, if we can only get our act together on Carbon Capture and Storage (CCS), we might be able to go on using it (Soapbox, this issue). Meanwhile, the geopolitical climate has just become more heated.

In the United States, the Trump administration has indicated its intention to support the domestic coal industry – a major plank in the President’s campaign, not only rolling back progressive environmental measures, but possibly putting the US on a collision course with the United Nations Minamata Convention on mercury pollution, at its first Conference of Parties (COP1) in Geneva this September. But – we have already grown used to the USA resiling from environmental agreements. We hear rather less about the failures of our European partner, Germany.

But – Germany is terribly ‘green’, isn’t it?

Well, no. Coal still provides 43% of its electricity. Coal is cheap, because its huge environmental costs are never factored in. And since Germany is committed to phasing out nuclear power by 2022 – for arguably entirely spurious environmental reasons in the face of the much greater threat posed by CO₂ – it is likely to stay that way.

Germany has pioneered wind turbines, and has many – mostly in the windy, industrial north. The power they generate is often wasted because coal plants burn on, regardless. Wind power works best when decentralised; but old power grids rely on distribution from point-sources. Germany has inadequate grid capacity for getting the north’s green surplus to the south. Meanwhile German emissions are not falling, but rising.

More surprising still, perhaps, Germany’s spending on

energy R&D has stagnated for a decade and – according to the OECD – is exceeded in its niggardliness only by the UK (although Germany is investing in Carbon Capture and Storage (CCS) research, as well it might, given its power mix). CCS works best for point-sources like power stations. Meanwhile Germany is behind on other ‘green’ targets too, including phasing in electric cars, and even insulating its buildings.

Germany’s much-vaunted legislative package, introduced in 2010 to support conversion to a low-carbon economy (*Energiewende*) has stalled. As Federal elections approach (I am writing in September) one must hope that the newly assembled Bundestag will have sufficient will to give *Energiewende* fresh life.

But even if it does, ‘coming off coal’ is not realistic in the short term. CCS, however, could give Germany breathing space.

SOCIETY NEWS

Research Grants



Applications are invited for the 2018 round of the Society research grants.

Please complete the form which can be downloaded from the Society Awards and Research Grants page at www.geolsoc.org.uk/grants where you will also find information about all the grants. The average award has been about £1000.

The Research Grants committee meets once annually. Applications must reach the Society no later than **1 February 2018** and must be supported by two Fellows of the Society who must each complete a supporting statement form. Only complete applications on the appropriate form will be considered. Stephanie Jones

Open House 2017



Volunteers from the staff who opened up Burlington House to the public on Saturday. L-R, Back: Michael McKimm, Marie Burke, Miriam Purdue, Flo Bullough, Sarah Day. L-R Front: Di Clements (Geologists' Ass.) Amy Ball, Eileen Jamieson, Ted Nield. (Not pictured: Caroline Lam, Fabienne Michaud - photographer)

The Society threw open its doors to the general public on Saturday 16 September, writes Dawne Riddle

Over 1100 people chose to visit the Society this year for Open House. In partnership with the Geologists' Association, who also ran some urban geology tours of the area, visitors

were invited to join one of seven guided tours during the day, led by Wendy Cawthorne, Sarah Day, Eileen Jamieson, Caroline Lam and Ted Nield. The Library also operated a 'pop-up bookshop' selling a variety of souvenirs and books, taking over £500 – a new record.

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



LONDON LECTURE SERIES

Why Earth developed into the crucible of life, and Venus into a hostile wasteland

Speaker: Dr Sami Mikhail (University of St Andrews)

Date: 22 November

Programme

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

Further Information

Please visit www.geolsoc.org.uk/gslondonlectures17. 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: **Sarah Woodcock**, The Geological Society, Burlington House, Piccadilly, London W1J 0BG,
T: +44 (0) 20 7432 0981 E: receptionist@geolsoc.org.uk

The Royal Commission for the Exhibition of 1851



For reasons lost in the mists of time the President of the Society is an ex officio Commissioner of the Royal Commission for the Exhibition of 1851.

Applications are now open for their various Awards, including Research Fellowships. For further information please go to: W: <https://www.royalcommission1851.org/awards/>





The Panel. L-R: Author Tom Bergin (Reuters), Clare Short, Mark Steeves, Sir Mark Moody-Stuart (chair, Royal Dutch Shell Group 1998-2001, chair of Anglo American plc 2002-09, non-executive director of Saudi Aramco since 2007, and Society President 2002-04), Peter van Veen (Transparency International)

Trust & transparency

Mark Steeves* says oil & gas, and mining, have done much to improve their transparency, but trust comes slowly - and more effort is needed

In April 2017 *Geoscientist* (27.3) reported on an event that took place on 21 February entitled: Trust & Transparency in the Oil & Gas and Mining Industries. It was organised by the City of London Geosciences Forum, an initiative of the Society's Corporate Affiliates Committee aimed at building understanding between the Society and the City of London - especially those bankers, insurers, lawyers, Nomads, accountants, brokers, who depend upon the exploration activities of geologists for their business.

The Rt. Hon. Clare Short, former Labour MP for Birmingham Ladywood (1983-2010) and Secretary of State for the UK Department for International Development (DfID, 1997-2003) opened the meeting. As she explained, her interest in transparency, and her passion for international development had led to her becoming chair of the Extractive Industries Transparency Initiative (EITI, 2012-16).

In an overview of EITI since full establishment in 2006, Ms Short said that the issue of illicit financial flows had quickly risen to the top of the international agenda, where it remained. Of the \$3.5 trillion annual gross revenue generated globally by extractive industries, an estimated \$1 trillion is lost by producing countries through corruption, illegal resource exploitation and tax evasion.

Trump

While acknowledging that progress had been made, she noted one of President Donald Trump's early "ominous" actions - to rescind the 'Dodd-Frank' provisions requiring extractive companies to report, country by country, what they pay to governments. She accused the American Petroleum Institute (API, and by extension, extractive industries at large, and therefore some in our audience) of having lobbied unrelentingly against those provisions. Some API members, she said, now "sit on the EITI Board - and thus the ramifications could be considerable".

Ultimately, I think we learnt that our industry today (certainly at the high-end, and in the UK) is actually fairly transparent. Society President Malcolm Brown (Executive VP Exploration at BG until 2016) will have been pleased to hear Peter van Veen say that BG came top among oil and gas companies in Transparency International's 'Corporate Political Engagement Index', which assesses the public reporting of the top 40 companies in the FTSE 100. Moody-Stuart defended Shell's historic actions, in Nigeria, for instance, reasonably and pretty convincingly; robustly commending Shell's commitment today to good governance and to EITI. He agreed that Short was rightly critical of API, and deplored US extra-territoriality.

Right thing

Peter van Veen asked - and answered - an obvious but pertinent question about beneficial ownership: "What does happen to the money, after it reaches government? It often ends up in countries where there are no beneficial ownership rules, where you can't tell who owns assets. Ten percent of Westminster is owned by offshore vehicles from the British Virgin Islands. Why do we allow this? What good reason can there be not to be transparent?" Quite.

A delegate from our hosts, Norton Rose Fulbright, suggested from the floor that corporations couldn't be blamed if resource-rich host governments are poorly served by their civil service. Clare Short, not interested in apportioning blame, asked rhetorically in reply: "Is it the company's duty to do a 'good' deal, or not?". Tom Bergin pointedly observed that companies don't just 'happen' on situations, but conspire in creating them; citing the way North Sea bare-boat charters "are clearly structured artificially". (My early career was spent chartering supply-boats, and I well remember how "imaginative" their ownership structures could be!)

We like to think we've done a lot to improve the way we do business, but much remains to be done. Even when we want a 'good' - by which I mean a 'clean' - deal, we often find ourselves facing competing and conflicting pressures. How 'good' is your agent, broker, adviser, operating partner, or legal advice? Consider the advantages of 'having a good agent' - and the almost total impracticality of not having one, in some countries. A 'big brand' company may have options often unavailable to young entrepreneurs and small businesses; but the big and powerful may not be agile, innovative or responsive - either to clients or civil society.

Mistrust

Public mistrust in the extractive industries, which in the mid-2000s led to EITI being created, has not noticeably diminished. And despite a large number of registrations for our event, the relatively low turnout might suggest that industry professionals and City firms supporting and serving the industry are either uninterested, think they know all there is to know and how to deal with the regulations, or both. Not good.

With the passing of time, it has become clear that this event raised as many questions, as it provided answers. In the future, the CLGF intends to hold more events that bear on what might most broadly be termed ethics, and the expectations and behaviour of the professions operating in and around extractive industries, as well as of the public.



*Clare Short's full speech is available with the Online version of this article. **Editor**
* Mark Steeves is founder and director of Samphire & Associates Ltd. He is also a Friend of the Geological Society and sits on both the Corporate Affiliates Committee and the City of London Geoscience Forum Steering Committee

Honorary Fellowship

Following a proposal from the External Relations Committee, Council recommends Professor Min Huh for election to Honorary Fellowship at a future Ordinary General Meeting.

Min Huh has been a hands-on, field-orientated palaeontologist for more than 30 years and as a leader is energetic and prominent in promoting the Korean geosciences internationally. He continues to publish significant, well-cited papers in his field and at the same time plays important roles in national geoscience outreach and policy, as Director of the Dinosaur Research Centre and as President of the Geological Society of Korea. He led a major

initiative to have the Korean Dinosaur Coast nominated as a UNESCO World Heritage Site, in 2009, and it remains on the list to be considered for this status at a later date. In 2016, he led the successful Korean application to host the 37th International Geological Congress in 2024 and is now co-chair of the implementation committee. The Society expects to take an active part in the 2024 IGC and hopes to develop and strengthen links with relevant Korean national organisations in the intervening years.



Society Discussion Group

Programme: 2017

Meetings of the Geological Society Discussion Group (formerly the Geological Society Club) are 18.30 for 1900, when dinner is served.

Attendance is open to all members of the Society. For up to date information concerning topics for discussion and speakers, please go to **W: <http://bit.ly/2IkAvbd>**

◆ **6 December** Athenaeum (London SW1Y 5ER)

2018

7 February (Gay Hussar)

14 June (Athenaeum)

24 October (Bumpkins)

24 April (Burlington Hse.)

12 September (Gay Hussar)

5 December (Athenaeum)



FUTURE MEETINGS

Dates for meetings of Council and Ordinary General Meetings until June 2017 will be as follows:

◆ OGMs:

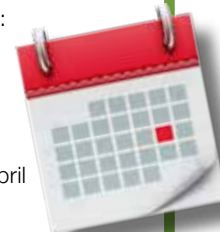
2017: 22 November,

2018: 7 February, 4 April

◆ Council:

2017: 22 November,

2018: 7 February, 4 April



Latest news from the Publishing House

Jenny Blythe has the latest from the Geological Society Publishing House

A new anurognathid pterosaur with evidence of perching behaviour



A new anurognathid pterosaur, *Versperopterylus lamadongensis* gen. et sp. nov., is erected based on a complete skeleton with a skull preserved. It is characterized by two short distinct ridges pre-sent on the ventral surface of the cervical vertebrae; coracoids slightly longer than scapula; humerus, wing phalanx 3 and tibia nearly the same in length; grooves clearly present on the posterio-r surface of the wing phalanges 1–3; and the first toe reversed. It is the first anurognathid pterosaur from China with a definitively short tail, and the first pterosaur with a reversed first toe. The reversed first toe of *Versperopterylus* indicates that it had arboreal habitats. The discovery of *Versperopterylus lamadongensis* from the Jiufotang Formation strongly expands the geological age range for anurognathid pterosaurs.

➤ **Read here** <https://doi.org/10.1144/SP455.16>

New Book

Geomechanics and Geology

Edited by J.P. Turner,
D. Healy, R.R. Hillis
and M. Welch



Geomechanics investigates the origin, magnitude and deformational consequences of stresses in the crust. In recent years awareness of geomechanical processes has been heightened by societal debates on fracking, human-induced seismicity, natural geohazards and safety issues with respect to petroleum exploration drilling, carbon sequestration and radioactive waste disposal. This volume explores the common ground linking geomechanics with inter alia economic and petroleum geology, structural geology, petrophysics, seismology, geotechnics, reservoir engineering and production technology.

➤ **Find out more here**
www.geolsoc.org.uk/SP458

One last roll for coal?

Former President **Bryan Lovell*** says Carbon Capture and Storage is the last roll of the dice for fossil fuels



The June editorial (*Geoscientist* 27.5 – ‘Coal is Dust’) described a divisive threat to our Society at the end of the last century. Ted Nield illustrated a local story of the gulf between the British coal industry and the environmentalists: ripples at the edge of the pond.

During this century, as the climate ‘sceptics’ have squared up to environmentalists, the Geological Society has remained a unified body. The key to that unity is observational science. We rely on the evidence from the rocks.

We continue to argue with each other about climate change, and much else, in the Lower Library and in *Geoscientist*. We do so happily, because we know that in the end none of us can argue with the rocks themselves. We will go out in the field, look at the rocks again, and hope to see who was right.

Policy

In 2010 the Society published a statement of policy on human-induced climate change. The report was prepared by a group of Fellows renowned for their knowledge of the record of past climates preserved in rocks and ice. The only guidance provided by Council was that these mighty scholars should stick to those tangible records in assessing whether we really did have a problem requiring attention. We do.

The geological case for concern about human-induced climate change has

strengthened since 2010. One example: we have new evidence from the geological record of the Paleocene-Eocene Thermal Maximum (PETM) in Spitsbergen and China. That evidence suggests that the input of carbon that triggered the PETM was an order of magnitude less rapid than our own rate of release of carbon to the atmosphere: disturbance of Earth systems at speed by us.

Challenge

We challenge those at both ends of the public argument on climate change. The climate sceptics flounder when presented with evidence from the geological record. Environmentalists with a general aversion to the fossil-fuel industry fret at geological support for carbon capture and storage (CCS).

That geological contribution to development of commercial-scale CCS becomes ever more significant. Academic and industry scientists work together on successful field trials of storage in conventional hydrocarbon-style traps.

Field trials

I declare an interest, as consultant to BHP, in research sponsored by that company on storage in open systems. This project is now underway at the Universities of Cambridge, Melbourne and Stanford. The aim is to quantify capillary, solution and mineral trapping of carbon dioxide in a range of reservoirs. Successful field trials of trapping by these mechanisms would transform the debate on CCS.

Until this research is complete, it is premature to consign any type of fossil fuel to the scrapheap. We geologists have been set the challenge of finding adequate safe storage for carbon dioxide. If we can’t do that, the fossil-fuel game is indeed up. If we can, we can continue to use coal, gas and oil. We have seldom had a more important job to do.

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).

“WE GEOLOGISTS HAVE BEEN SET THE CHALLENGE OF FINDING ADEQUATE SAFE STORAGE FOR CARBON DIOXIDE. IF WE CAN’T DO THAT, THE FOSSIL-FUEL GAME IS INDEED UP”

BRYAN LOVELL

*Bryan Lovell is at the University of Cambridge



HIDDEN TIGER



Graham Leslie* and Rhian Kendall**

explore the geology beneath one of the world's fastest growing cities - Singapore

Above: Singapore, Asian Tiger City - arguably one of the world's most competitive places and certainly one of its most densely populated

The Republic of Singapore is a hugely vigorous and dynamic hub for global finance, commerce, and transport links, and is arguably one of the world's most competitive countries. The only island city-state on the planet, and frequently cited as the most 'technology-ready' nation, Singapore is the world's third-largest oil refining and trading centre, its second-busiest container port, largest oil-rig producer and a major hub for ship-repair services.

Looking to the future, Singapore today aspires to becoming a 'smart' nation – one that integrates transportation, utilities and service infrastructure with information communications technology (ICT), in order to facilitate the sustainable management of its societal assets.

Natural resources

The resulting demand on Singapore's constrained land and natural resources is high. A growing population of over 5.6 million lives within an area of only 700km², a population density of some 8264 people per km² in an area approximately the same size as Anglesey (Ynys Môn) in North Wales! Although half of Singapore's land area comprises spectacular nature reserves, parks and gardens, natural outcrop is now extremely rare at surface; and so, getting to grips with Singapore's geology is always challenging. Despite these challenges however, it is becoming increasingly clear that the story of Singapore's geological evolution from Carboniferous times on, was diverse, often complex, and rapidly changing

“ UNDERSTANDING THAT GEOLOGICAL INHERITANCE, AND COMMUNICATING ITS MOST SIGNIFICANT CHARACTERISTICS TO SINGAPORE’S GEOLOGICAL COMMUNITY, IS VITALLY IMPORTANT TO THOSE RESPONSIBLE FOR FUELLING AND SUSTAINING THE COUNTRY’S CONTINUED GROWTH ”



Photographs, top and bottom: The BGS has worked together with the BCA to revise the current stratigraphy of Singapore. These fieldwork pictures illustrate the mapping teams using foreshore outcrops, a vital source of information in this outcrop-poor terrain

– at least on a geological timescale.

Understanding that geological inheritance, and communicating its most significant characteristics to Singapore’s geological community, is vitally important to those responsible for fuelling and sustaining the country’s continued growth.

Taking a long-term view, the Singapore Government has already invested heavily and strategically in the creation of land and space, establishing an Economic Strategies Committee (ESC) in 2009. The Singapore Government is developing an underground master-plan and ‘land bank’, with a view to ensuring that underground and aboveground spaces are better integrated with surrounding developments and infrastructure.

All underground and other

geological information that will benefit both private and public sector efforts in underground development has now been collated, and a subterranean land rights and valuation framework is being developed. The British Geological Survey (BGS) has been working with the Geological and Underground Projects Department in of the Building and Construction Authority (BCA) since 2012 to deliver this modern geological knowledge-base. This article tells the story (so far!) of the fascinating geology emerging from beneath the Asian Tiger City.

Reclamation

Since the 1960s, land reclamation projects have increased Singapore’s land area by almost 24% - to

c. 720km² in 2015. Its surface area is projected to grow by another 100km² by 2030.

Singapore presently comprises 63 separate islands; some of these reclamation projects involve merging smaller islands to form larger, more functional islands (as has been done with Jurong Island in the south west). In still more ambitious plans, the subsurface is seen as an attractive development space for, among other things, basements, energy production and infrastructure, waste disposal and treatment, groundwater abstraction and water storage, transportation, industrial manufacturing, and logistics.

Planning

Geological and geotechnical understanding of Singapore’s sub-

Although highly built up, it is possible to find outcrops along the foreshores of Singapore's many outlying islands



Singapore has taken advantage of the proximity of its outlying islands to, in some cases, join them together



Photo: Hudson Shiraku

BGS' copy of Mary Alexander's geological map of Singapore



Marina Bay Gardens, Singapore – all on land reclaimed from the busy Singapore Strait



► surface is critical to planning, design and construction of a future-proof city infrastructure. Very significant parts of that infrastructure will comprise enormous underground facilities, and land-scarce Singapore is already storing some of its military resources in this way.

The giant cavern facilities beneath Jurong Island entered service for oil storage in September 2014. This cavern complex lies some 150m below ground, delivering a storage capacity of 1.47 million m³ of liquid hydrocarbon - equivalent to some 580 Olympic-sized swimming pools. This capacity will double when the second phase of the work is completed.

In the last decade, the push to go underground has seen potential uses of cavern space as water reservoirs, power stations, port logistic systems, data centres, warehousing and storage all under consideration. The state-of-the-art underground MRT system for Singapore's growing population continues to expand rapidly.

Bedrock is now preserved only sporadically at the modern metropolitan surface. Most natural outcrop is confined to coastline and to disused quarries, many of which are now flooded or in varying stages of reclamation.

The present new study is only made possible because of a new and comprehensive ground investigation programme commissioned for the BCA. This includes acquiring drillcore from more than 100 boreholes. Each borehole is typically about 200m deep, extending from

the ground surface to some 70m below the engineered floors of any anticipated cavern storage space designs - totalling approximately 13, 400m of new drillcore. Some 100km of new seismic reflection and refraction data have been acquired in a number of designated development areas; all these new data are having a very significant impact on current understanding of Singapore geology.

None of the geological record that emerges from beneath the modern Singapore cityscape is straightforward. Embedding robust geoscience knowledge in sub-surface planning will help ensure that the future decision-making process will be well informed and so improve urban resilience.

Singapore rocks

Singapore lies at the southern end of Peninsular Malaysia, in a region dominated by the geological history of two continental fragments (Indochina-East Malaya and Sibumasu) that separated from the supercontinent of Gondwana during the Palaeozoic. These fragments are now joined together, along with rocks assigned to the Sukhothai Arc terrain, along the trace of the Bentong-Raub Suture Zone (see map p15).

Singapore's oldest rocks are thought to be the siliciclastic sedimentary rocks of the Sajahat Formation, which crop out on the island of Pulau Tekong in north-eastern Singapore. Although the Formation's age is not proven conclusively, these rocks have been thermally metamorphosed by the intrusion of granitic and associated mafic intrusive rocks of Permian to mid-Triassic age. The Central Singapore Granite and Gombak Norite plutons are a conspicuous feature on the geological map.

In western and south-western Singapore the Mid- to Upper Triassic (to earliest Jurassic?) volcano-sedimentary Jurong Formation (which has been assigned Group status in the BGS's new proposed lithostratigraphical framework) was originally deposited in an active fore-arc basin as a shallow marine to terrestrial succession, broadly contemporaneous with the younger elements of the plutonic rocks. The sedimentary succession is punctuated

by volcanogenic deposits that issued from the still-active arc; 240 million year-old tuffs are interlayered with Carnian/Norian fossil assemblages, all pointing to a mid- to late Triassic history.

Now folded, thrust and cleaved, these Jurong strata record deformation and low-grade metamorphism that resulted when the fore-arc sequence became accreted onto Mesozoic Indochina-East Malaya during collision and suturing with Sibumasu across the Bentong-Raub line.

During the earlier stages of that collision, and possibly as the subducting oceanic slab detached, the older inner fore-arc succession was buried beneath a 20 – 30Ma younger fluvial succession laden with volcanic, plutonic and metamorphic detritus. Gradually, that fluvial succession became more tidally dominated again, as relative sea-levels rose in the earliest Jurassic. Terminal collision of Sibumasu and SE Indochina- East Malaya ('docking') marked the end of deformation, focused in the Bentong-Raub suture zone. NE-vergent fold and thrust-belt deformation developed on the eastern side of the suture zone, affecting upper Triassic to earliest Jurassic strata.

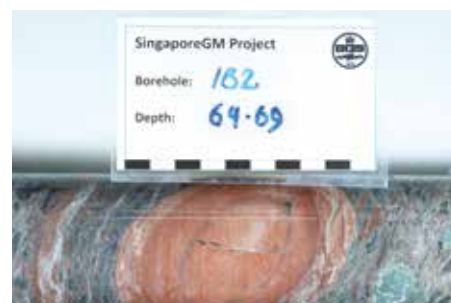
Deformation ended by about 195Ma and that terminal collision was followed by a long period of deeply penetrative weathering and erosion for c. 50 million years during the later Jurassic. No mid- to upper Jurassic strata are preserved.

Variably cemented Quaternary sands and gravels cover much of eastern Singapore Island. These are thought to have been deposited by braided river systems, flowing broadly southwards into the Straits of Singapore. They are known as 'Old Alluvium' in both Johor and Singapore (attributed to the Bedok Formation within the new proposed lithostratigraphical framework).

The youngest part of the succession comprises unconsolidated marine to terrestrial sediments of late Pleistocene to Holocene age, which are assigned to the Kallang Formation (also elevated to Group status in the BGS proposed lithostrat framework).

Pioneer

It is important though to acknowledge that our work did not start from



Above: Marina Bay Gardens, Singapore – all on land reclaimed from the busy Singapore Strait
Upper Middle: Half of Singapore's land area today comprises spectacular nature reserves, parks and gardens
Lower Middle: Deformed volcanic clast in tuffaceous conglomerate in drillcore, cm scale
Below: The giant cavern facilities beneath Jurong Island entered service for oil storage in September 2014

“NONE OF THE GEOLOGICAL RECORD THAT EMERGES FROM BENEATH THE MODERN SINGAPORE CITYSCAPE IS STRAIGHTFORWARD”

► nothing. One of the first geological maps for the whole island of Singapore was created by Dr Elizabeth Alexander and published in 1950. Frances Elizabeth Somerville Alexander (1908-1958) was a pioneering scientist (see this month's second feature, p17). She was awarded a PhD from Cambridge University in 1934 with a thesis on the main outcrop of the Aymestry Limestone (Silurian, Upper Ludlow Shales Group).

After her marriage the couple moved to Singapore in 1936, where they had a family of three children. Alexander worked for the Royal Navy on radio direction-finding, during which time she held the rank of Captain. She is, arguably, most well-known as the first female radio astronomer, discovering in 1945 the 'Norfolk Island Effect' - the connection between an increase in radio noise associated with the sun (solar radio emissions).

In 1942, with the threat of Japanese invasion looming, Alexander fled with her children to safety in New Zealand. Believing her husband to be dead (he was actually a prisoner of war at Changi), she remained there, and was appointed head of the Operations

Research Section of the Radio Development Laboratory. After they were reunited, the couple returned to Singapore in 1947. Alexander became a geological consultant and in 1949 was appointed Geologist to the Government in Singapore.

Her main task was to make a survey of the islands resources of granite and other useful stone - one conclusion of which being that the island's granite resources should last for 500 years. Alexander died in 1958, a few months short of her 50th birthday. Her contribution to geology and radio astronomy is extraordinary, considering her short life, detailed knowledge of two disciplines, and the traumatic circumstances in which she made it.

Our present work on Singapore's subsurface geology rests on the pioneering work carried out by Alexander, often in the most difficult of circumstances. It is with a certain pride that by building on what she achieved, we are able to draw attention to this sadly neglected figure, whose daughter is currently engaged in writing her biography. The Asian Tiger City owes her a very great debt indeed. ♦



Sir Thomas Stamford Raffles, FRS was a British statesman, Lieutenant-Governor of British Java and Governor-General of Bencoolen, best known for his founding of Modern Singapore

Photo: Julia Somerville/shutterstock.com

Photo: Kroisenbrunner, Wikimedia Commons.



Panorama of Keppel Container Terminal, Singapore



Geological and geotechnical understanding of the Singapore sub-surface is critical to planning, design and construction of a future-proof city infrastructure



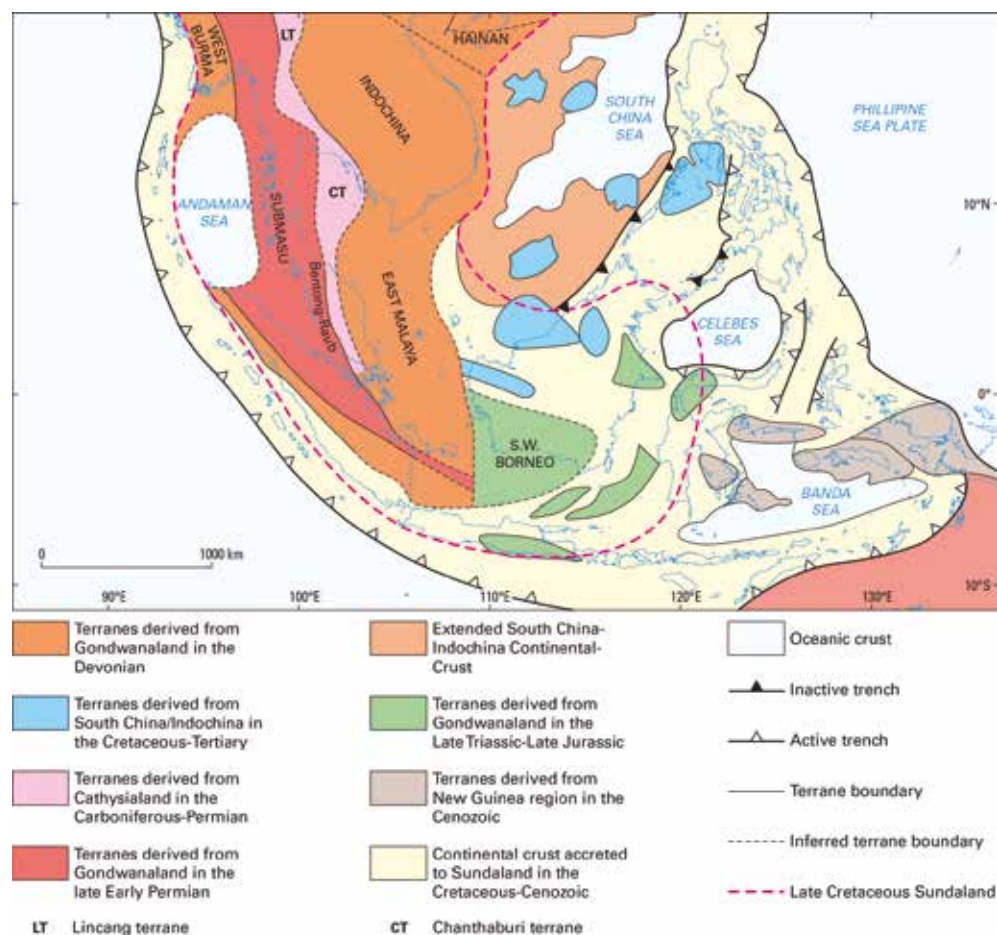
Dr Elizabeth Alexander 1908-1958 (courtesy: Mary Harris)



Above: Marina Bay Gardens, by night



Below: Some of the c. 13km of new core laid out for examination



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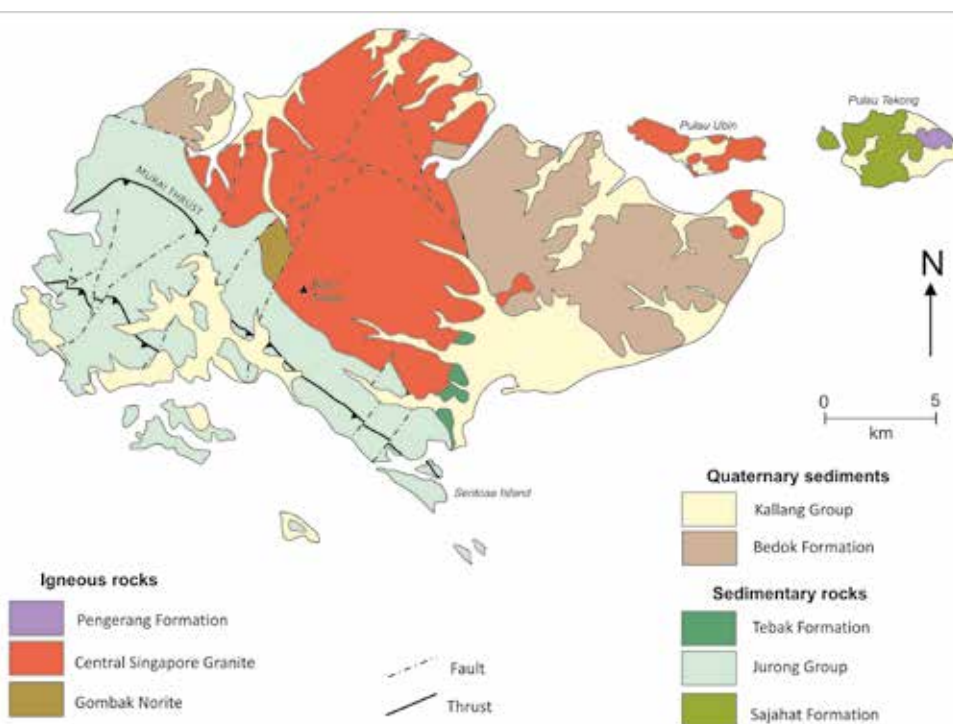
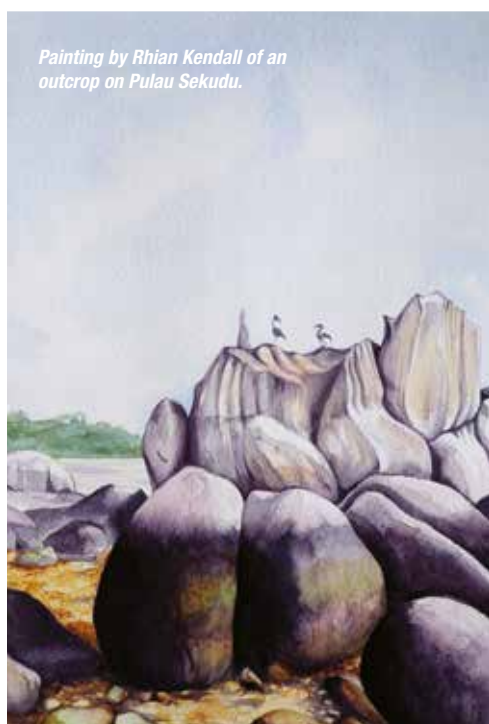
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*BGS Scotland, The Lyell Centre, Edinburgh EH14 4AP: E: agle@bgs.ac.uk. **BGS Wales, Cardiff University, Main Building, Park Place, Cardiff CF10 3AT, Wales. Published with the permission of the Executive Director, British Geological Survey

Painting by Rhian Kendall of an outcrop on Pulau Sekudu.



Top left: Singapore lies at the southern end of Peninsular Malaysia, in a region dominated by the geological history of two continental fragments (Indochina-East Malaya and Sibumasu) that separated from the supercontinent of Gondwana during the Palaeozoic. These fragments are now joined together, along with rocks assigned to the Sukhothai Arc terrain, along the trace of the Bentong-Raub Suture Zone. Permian to mid-Triassic granitic and mafic intrusive rocks from that arc dominate central Singapore. In western and south-western Singapore a mid- to uppermost Triassic (to earliest Jurassic?) volcano-sedimentary succession was originally deposited in an active fore-arc basin as a shallow marine to terrestrial succession, broadly contemporaneous with the younger elements of the plutonic rocks of Singapore. After Metcalfe (2011) and Hall (2009)

ELIZABETH ALEXANDER

SCIENTIFIC PIONEER



*Mary Harris recounts her mother's role in investigating the geology of Singapore

Much of the current geological work in Singapore has developed from the work of Dr Elizabeth Alexander: particularly from that published in her Granite Report of 1950¹ with its enfolded map. She had come to Singapore in 1936 with her husband, New Zealander Norman Alexander, Professor of Physics at Raffles College, but began research on the island's geology under her own initiative almost as soon as she arrived.

Malay States

In the colonial era, Singapore was included with Malaya in a complicated organisation of Federated and Unfederated Malay States and Straits Settlements, and the only comprehensive publications on the geology of the region were those of John Brooke Scrivenor, appointed first Director of the new Geology Survey Department of the Federated Malay States in 1927. He had worked in Malaya since 1903 with a small and fluctuating staff, from headquarters in Kuala Lumpur; but by the time Elizabeth arrived, the Department's headquarters was in Batu Gajah, near Ipoh - accessible from Singapore by road and air - where it remained until after the end of colonial times.

Scrivenor's publications had been accessible to Elizabeth in Cambridge University Library, (where her 1935 PhD in geology is archived) in the Raffles Museum and Library in Singapore, and through the Geological Survey, headed by Eric Willbourn following Scrivenor's retirement in 1931. Elizabeth developed a particular interest in erosion under the warm and humid climate of Singapore, finding that under certain circumstances, iron, aluminium and silica were mobile and were involved in the formation of new rock at unexpectedly high speed.

Mangrove swamp

By 1940, she had buried some rock samples in mangrove swamp, to compare some years later with controls in the lab which she had set up in her own home. She was

still freelance as a geologist, but by 1938 had begun war work at the Singapore Naval Base, where she was employed in Radio Direction Finding (RDF). At that time the Admiralty was setting up a network of long-range, high-frequency, radio direction finding stations, with Singapore as their control centre. Singapore had particularly close links with New Zealand, whose Navy was still a squadron of the Royal Navy and which, as a country, was well advanced in wireless technology.

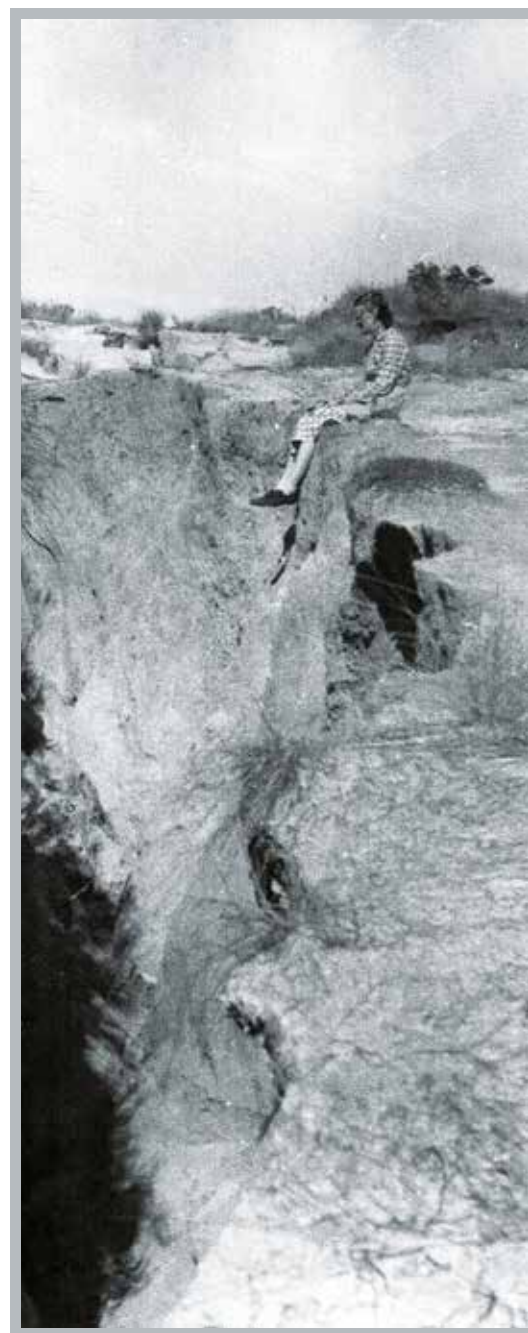
Invasion

The Japanese Army invaded Malaya in December 1941 and advanced rapidly down the peninsula. Elizabeth was ordered to take her three children to safety with her husband's family in New Zealand, and to return to the Naval Base with specialist equipment then being manufactured in Sydney. But she was overtaken by events. Singapore fell, and she found herself stranded with no income and no news of her husband and needing to find work so that she could rear her children.

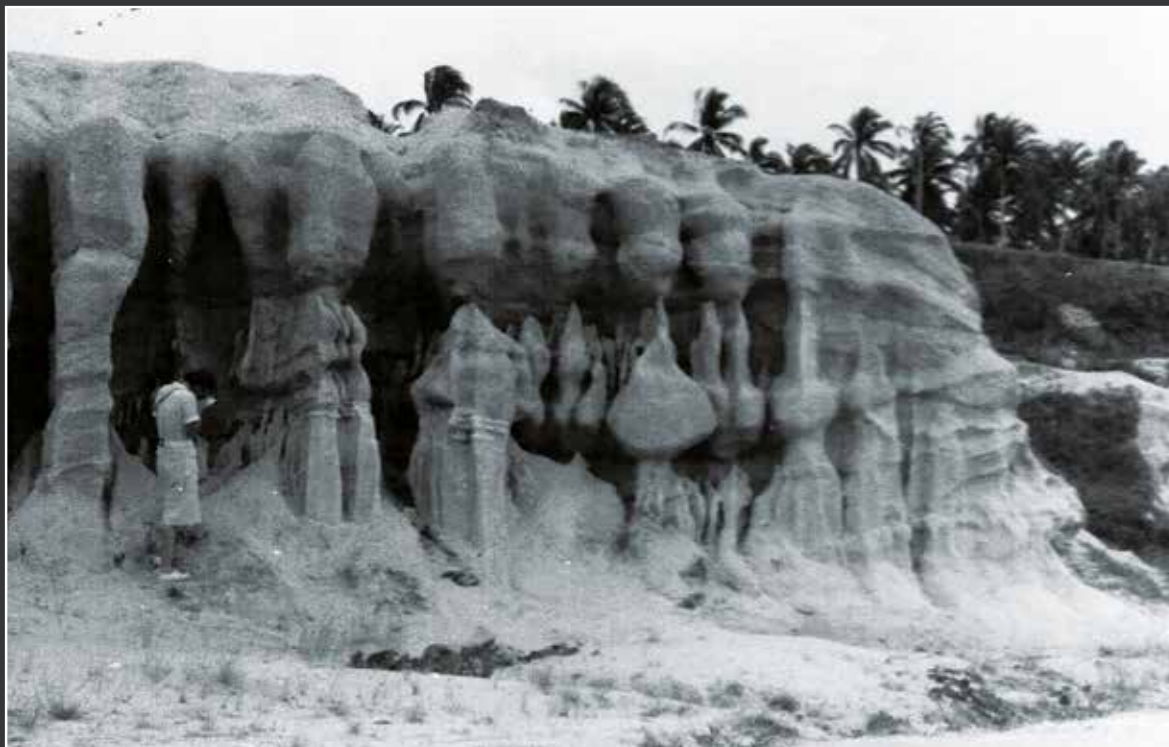
Through contacts with colleagues from Cambridge University days who were by then working in radar (not yet called that, but disguised under the name of 'RDF') and her Singapore Naval Base link with the New Zealand part of the RDF network, she was invited to set up and run the Operational Research Section of New Zealand's Radio Development Lab, the secret radar research department of New Zealand's Department of Scientific and Industrial Research.

During her four years there, she was responsible not only for the operational effectiveness of New Zealand's own radars (thrown into prominence in the South Pacific theatre, following Pearl Harbour), but also for two major pieces of research, which faded from history until the very recent publication of New Zealand's WWII Radar Narrative. One became the beginning of the science of radio astronomy in Australia and the other the Canterbury Project.

Elizabeth could proceed with neither



Above: Elizabeth Alexander at Kampong Eunus Earth Quarry. Survey Museum London 1950
Left: Elizabeth Alexander, pioneering scientist of Singapore



Kampong Eunus Earth Quarry, showing wind and water erosion. Survey Museum London 1950

► of them herself because her contract with the New Zealand government ended with the end of the war. Her husband re-appeared from internment in Singapore and eventually, she herself was back in Singapore in 1947. It is relevant to note however, that her work as Head of Ops Research in New Zealand, in which she was employed as Senior Physicist, was as significant to the development of radio science as her work in the science she loved best was to become in the development of the geology of Singapore.

Recovery

In Singapore in 1947 the priority was recovery from occupation. Continuation of her own research was made impossible because her house, which included her lab, had been looted to complete emptiness by the British Army of Reoccupation. Instead, she worked to help re-establish Raffles College, in various consultancies concerned with Singapore's neglected or damaged infrastructures, and in acting as Temporary Registrar for the new University of Malaya while preparing specimens and slides for teaching in a geology department there as soon as it opened.

In 1949 she was commissioned by the Singapore government to survey the Island for sources of granite for reconstruction and to publish the Granite Report named above. Her attempt to restart her own weathering research was further obstructed because, during some road building, the occupiers had sliced the top off a hill which bore a triangulation point, crucial in locating her buried basket

of rocks. Then, her husband was head-hunted to Ibadan, Nigeria where University College Ibadan (then an internal college of London University) would need its physics department upgraded in time to undertake ionosphere research for the International Geophysical Year of 1957/8.

Elizabeth was unhappy to leave her own Singapore geology research for a second time, but her husband, affected like all internees by his experience, needed her help and she put him first. At University College Ibadan, she took a junior post in the Agriculture Department under the rule that wives of expatriate staff could not undertake employment if a qualified Nigerian was available, and attempted to start some weathering research again. Meanwhile Michael Tweedie of Raffles Museum, a naturalist with great experience of and fondness for mangrove swamps, found one of Elizabeth's baskets of rocks and had it sent to the Rothamsted Research Station, just outside London, where she could examine the rocks during annual leaves from Nigeria.

Stroke

Her paper² was read at the Geological Society, shortly before she died and published posthumously. During an unsuccessful argument with the College Principal at Ibadan for the development of a geology department which she had already set up at her own expense, she suffered a cerebral haemorrhage and died a week later. She was not quite 50 years old, but in her short life, hampered by war and its lasting effects, she had changed thinking in two separate sciences. Then

she disappeared from both sciences until, with the publication of the New Zealand Radar Narrative and renewed geological research in Singapore, people began asking who this remarkable scientist was. My forthcoming biography³ intends to try to explain.

Elizabeth Alexander would have been particularly pleased to see the lasting effects of her Singapore work both in Singapore and in England. The second edition of *The Geology of Singapore* by Lee Kim Wee and Zhou Yingxin, was published in 2009 by Singapore's Defence Science and Technology Agency in collaboration with the Building and Construction Authority of Nanyang Technological University, and made available online through researchgate.net by author Professor Zhou in 2016.

Her work is cited, discussed and developed throughout the book as new generations of Singapore geologists work collaboratively with government departments which need to use it. At the same time, the British Geological Survey is working collaboratively in Singapore in building its three-dimensional model of the island. At a time when so much of Singapore's land has been bulldozed and built on, Elizabeth's 1950 report, map and photographs are the only record of earlier, more accessible geology.

At the same time, her posthumously published paper on tropical weathering in SE Asia has significance for recent work on the Hertfordshire Puddingstone. Lovell and Tubb (2006) suggest that cementation of this famously hard rock took place "... beneath a 55Ma land surface that enjoyed



Above: Norfolk Island
Below: Singapore Naval Base



Elizabeth Alexander
in the field.
Survey
Museum,
London
1950



Singapore
today is highly
developed and
yet also richly
supplied with
natural reserves
- a very different
place from the
one encountered
by Elizabeth
Alexander

a climate closer to that of present-day Penang (in Malaysia) rather than that of Puckeridge.”⁴ ♦

ACKNOWLEDGEMENT

I am grateful to Professor Yingxin Zhou and Marcus Dobbs for personal communications about the significance of Elizabeth's legacy in their current work.

* **Mary Harris** is writing the biography of Elizabeth Alexander. E: mary@maryeharris.plus.com

FURTHER READING

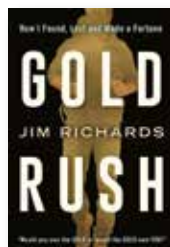
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Statue and
plaque
commemorating
Sir Stamford
Raffles



Gold Rush – how I found, lost & made a fortune



It was a pleasure to meet geologist and former parachute regiment soldier Jim Richards when he delivered a lecture to the North West Regional Group of the Geological Society on

this, an autobiography of his career in gold mining and an epic geological tale of rocks, survival and endurance at the most inhospitable ends of the Earth.

This is a no-holds-barred account of life at the sharp end of the exploration industry and, much like the man himself, it comes across as genuine and honest. The people are real, and the situations Jim vividly describes are as raw and real as they can get.

Jim tackles the thorny issue of providing accounts of events in which real people do not always display themselves in the best light with tact and diplomacy, and isn't afraid to share his own mistakes. As a former gold miner myself, it rang true on so many levels and brought back many happy (and somewhat dusty) memories of rock logging. There is plenty of geological description in here, and so much to be learnt from Jim's long field experience.

Along with thoroughly entertaining and informative anecdotes of gold, diamonds, oil, iron and more gold, there's a whole lot of guns, greed, sex, terrorism, corruption, disease and politics thrown in to boot. A representative of seemingly every corner of the animal kingdom has a go at him at one time or another, providing nightmarish encounters with rats, vampire bats, mosquitos, leeches, snakes, and perhaps the deadliest animal of all: the investment banker.

Jim's geological knowledge and his belief in his dream pull him through: he never gives up, and it is his tenacity of spirit and enthusiasm for geology that bring forth a tale of triumph in the face of adversity, the true possibilities of human achievement in the worst of circumstances and with the smallest of resources, for those who dare to walk the path. There's many genuine laugh-out-loud moments too. The encounter with Mitch The Canadian's handover notes had all of us rolling in the aisles.

An absolute must-read for any aspiring

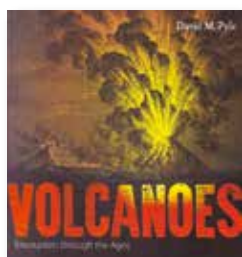
exploration geologist, it's also thoroughly digestible for non-geologists and a handily sized and nicely bound book complete with an interesting set of colour photo illustrations. If you like to read about genuine adventure and survival, then this is for you. AND it has rocks in it. What more could one ask?

Reviewed by: **Catherine Kenny**

GOLD RUSH - HOW I FOUND, LOST AND MADE A FORTUNE

by JIM RICHARDS, 2016. Published by: September Publishing 363pp ISBN: 9781910463369
List Price: £10.99
W: www.septemberpublishing.org

Volcanoes: Encounters through the Ages



Even if you didn't think you had any interest in either volcanoes or historical geological documents and references, a visit

to the Volcanoes exhibition which was held at the Weston Library in Oxford from February to May 2017 will surely have changed your mind.

The exhibition, based on original documents, books and volcano-related ephemera dating from ancient to modern times from the extensive collections held by the Bodleian Library was nothing short of spectacular and totally absorbing (see the review of the exhibit by Andrew Robinson in '2017 Book Reviews', *GeoscientistOnline*). Along with the chance to view rarely displayed original material, the exhibition was notable for the quality of the captioning, which explained just the right amount of the geological basics to put the historical material on display into context. With such a wealth of material on show, it took me several visits to take it all in.

Volcanoes: Encounters through the Ages is the book of the exhibition. It was clearly designed as a souvenir – albeit a fairly expensive one – to serve as a useful reminder of what the exhibit contained. However, unlike the exhibition itself, which I found totally absorbing, the book is a bit of a curate's egg – that is, very good in parts.

On the plus side it is beautifully produced and includes many wonderful reproductions of some of the documents and early photographs which featured in the exhibit. These range from clear reproductions of manuscript diary pages and letters from people who viewed eruptions first hand, to early 20th Century photographs and paintings of volcanoes and volcanic phenomena, and even old film posters designed to fire the public imagination. The text descriptions that accompany the illustrations seem to expand on the original exhibition captions and are informative and fascinating.

But the book also attempts to serve as an introduction to volcanology for the general reader, and this, I feel, is its weak point. Admittedly, it's not easy to explain the complexities of volcanoes to non-specialist readers. However, in contrast to the generally stylish and informative writing about the historical context, the science writing often seems clumsy and occasionally unintentionally patronising – an impression not helped by the excessive use of explanatory phrases in parentheses.

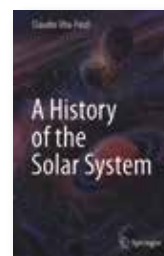
My advice: skip the Introduction, skim through the other 'science textbook' sections and focus instead the historical sections and wonderful illustrations. You'll be in for a fascinating, enjoyable and informative read and a feast for the eyes.

Reviewed by **Nina Morgan**

VOLCANOES: ENCOUNTERS THROUGH THE AGES

BY DAVID M. PYLE. Bodleian Library, Oxford, 2017, 223 pp. ISBN 978 1 85124 459 1
List price: £20/US\$35.00

A History of the Solar System



This is an unusual book, packed with information, and a difficult one to review. Rather than discuss the evolutionary history of the solar system (as I expected), Vita-Finzi chooses to talk about the history of some ideas that

have come about and developed through the study of our planetary neighbours. Each idea is assigned a chapter followed by a list of references.

To explain what the author's approach is all about, we must go back to 1584, when



Giordano Bruno first suggested our planets revolved around the sun. Now, we know there is a multitude of planets orbiting similar stars to ours in our galaxy. That's a pretty good, and relevant, idea!

In another chapter, the author explores the idea that the solar system is still changing. External ingressions must have had an influence. Vita-Finzi discusses a variety of potential influencers and our present ability to measure their effect.

This is a challenging read. Long sentences are common. They are replete with subsidiary clauses, which make parts of the text difficult to absorb. I often found I had to read a sentence several times to fully understand the gist. And, sometimes a word had obviously been dropped, which made me feel uneasy about my comprehension overall. Such blemishes are irritating and detract from the underlying value.

Despite these problems with editing, the book is cleverly conceived and a useful addition to any scientists bookshelf. It should provide a challenging read to students and graduates alike. Many seasoned scientists may enjoy taking a stab at it too.

In many ways, I understand and admire this brave attempt to conjure up a fresh and more interesting way to examine our local system. I hope there are better books to come.

Reviewed by **David Edwards**

A HISTORY OF THE SOLAR SYSTEM

by CLAUDIO VITA-FINZI. 2016 Springer.
100pp, sbk ISBN: 978-3-319-33848-4
ISBN ebook: 978-3-319-33850-7.
W: <http://www.springer.com/gb/book/9783319338484>

Radioactive Waste Confinement: Clays in Natural and Engineered Barriers

The current scientific consensus for the safest long-term management of higher-activity radioactive wastes is through geological disposal in engineered facilities constructed at an appropriate crustal depth, within stable geological formations (the geological disposal facility or 'repository'). Repository



development on a specific site requires the integrated and systematic analysis of the characteristics of the waste to be 'emplaced', the enclosing engineered barriers and the site's host rock and its geological setting. Three main host rock types are usually considered for geological disposal: crystalline rocks, evaporites (salt) and clays.

This GSL Special Publication concentrates on the importance of clays and other argillaceous materials in the development of geological disposal systems. Characteristically, clays display properties which can be exploited both as host rock and material for engineered barriers (as buffer, backfill or sealing material). Properties include low permeability, diffusive transport, retention capacity, buffering effects, self-sealing capacity, stability, vertical homogeneity and lateral continuity, which make clays significant barriers to radionuclide and chemical contaminant migration towards the surface environment.

Based upon the 6th International Clay Conference hosted by the Belgium National Radioactive Waste Management Agency (ONDAF/NIRAS) in 2015, the volume contains 25 papers grouped into six interrelated and multi-disciplinary topic areas: large-scale geological characterisation, general strategy for clay-based systems, geomechanics, mass transfer, bentonite evolution and gas transfer. These topic areas demonstrate the diversity of current geological repository research. Clay characterisation studies relevant to the confinement of radionuclides range from the fundamental process level, to the overall understanding of the performance and safety at geological and repository scales. Emphasis is placed on the modelling of processes operating at the mineralogical level within the argillaceous barriers.

The contributions are well-written and edited, complemented with appropriate figures, photographs and data-tables. A minor presentational criticism is that several data graphs are difficult to discriminate, reproduced as grey-scale images in the print copy - unfortunately distracting from the details described. Overall, a recommended read and valuable reference work for practising

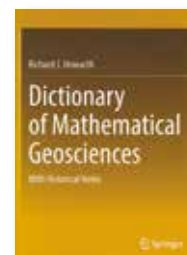
geoscientific professionals within the radioactive waste management sector.

Reviewed by **Mark Griffin**

RADIOACTIVE WASTE CONFINEMENT: CLAYS IN NATURAL AND ENGINEERED BARRIERS

by NORRIS, S, BRUNO J, VAN GEET M, & VERHOEF E (editors). Geological Society of London Special Publication No 443. 2017. Geological Society of London. ISBN 978-1-78620-273-4. Hbk. 376pp. ISSN 0305-8719.
List Price: £100.00, Fellows' Price: £50.00.
W: www.geolsoc.org.uk/SP443

Dictionary of Mathematical Geosciences



Browsing a dictionary is one way of picking up a foreign language, if there is no ready access to a native speaker. To the extent that the names of mathematical

methods are generally as foreign to geologists as the names of rocks are to mathematicians, this substantial dictionary of mathematical geosciences should be welcomed as a weighty addition to geological libraries.

In the modern digital era, where Google can provide instantaneous answers for any dictionary query, the need for a dictionary in paper or electronic format may be questioned. However, as with language dictionaries, the act of looking up something can serendipitously lead to an extra gain of knowledge. Nobody who browses this dictionary can fail to learn something interesting, even if tangential to their original query.

Any dictionary of mathematical geosciences of finite size carries the personal imprint of the compiler. Richard Howarth received his PhD at the University of Bristol and specialized in the statistical interpretation of geological and geochemical data as well as the history of the use of quantitative methods in geology and early geophysics. He worked for Shell International where he undertook computer programming and statistical analysis for a research project

relating the hydrocarbon production of world-wide sedimentary basins to their geology.

As an Imperial College lecturer in the Applied Geochemistry Research Group, he researched the application of statistical and computing methods to mapping and interpretation of regional geochemical survey data for mineral exploration, geological and epidemiological purposes.

Howarth's broad experience in industry and academia qualifies him as much as anyone else to produce his dictionary of mathematical geosciences, but inevitably some subjects are treated in greater depth than others. His personal interest in the history of the development of quantitative methods is evident throughout, with abundant references to geoscientists who have made substantial contributions.

Some readers may be disappointed that their own particular field of geoscientific enquiry is not as well represented as those with which Howarth is most familiar from his own career. Hopefully, this disappointment will be compensated by the reward of finding new nuggets of information and insight that may prove very useful. Some readers may be delighted to find some topics treated in considerable detail, bordering that of a basic mathematical dictionary. Being expensively priced, this volume is unlikely to be found outside libraries (though an e-book is available); but there it should be often browsed.

Reviewed by **Gordon Woo**

DICTIONARY OF MATHEMATICAL GEOSCIENCES WITH HISTORICAL NOTES

by RICHARD J HOWARTH 2017 Springer International Publishing ISBN 978-3-319-57314-4 (hbk). 893 List Price: £222.50 e-Book: £178.00 W: www.springer.com/gb/book/9783319573144

Soda Lakes of East Africa

There are many reasons for writing and publishing a book, but I suspect the best and most satisfying is 'fun'. Having now read this latest multi-author publication I firmly believe the 30 different authors had this as their primary motivation.

This book is probably not the last word on the subject of soda lakes, but



it is certainly a milestone in characterization and understanding. Covering geology, geochemistry, limnology, zoology, microbiology, environmental and cultural assessment of the soda lakes of East Africa, particularly those of Kenya, this volume provides comprehensive coverage.

The editor, Michael Shagerl (who is also a contributor), has done an extremely good job of assembling like-minded enthusiasts. Starting with an assessment of the physio-chemical environment of the lakes, their formation, hydrology and geochemistry, the book then moves to their associated fauna and microfauna. The final chapters cover issues of conservation and environmental assessment, the challenges in managing the lakes, and potential future scenarios. Despite the comprehensive nature of the chapters, the volume ends with a 'shopping list' of issues that still need resolution in our understanding of these unique environments.

The book would seem, at first glance, to be aimed at a highly specialized audience; but if you take a step back from the title, you realise on reading it that the volume is a blueprint for how one should assess an ecosystem - from understanding its geological formation and characteristics, to the micro and macro fauna (and looking to the future to assess potential conflicts and knowledge gaps).

I would therefore recommend this book to any geoscientist. It allows the reader to see how our science interplays with other natural sciences, and the close interconnection between geosphere and biosphere. The book is extremely well edited and the chapters well written: a lasting testimony to the considerable effort the editor and authors have applied. Strongly recommended for anyone who thinks about our natural world.

Reviewed by **Rob Bowell**

SODA LAKES OF EAST AFRICA

by MICHAEL SCHAGERL (ed) 2017. Springer International Publishing ISBN 978-3-319-28620-4 (hbk) 408pp, List price: £100.50. eBook £80.00. W: <http://www.springer.com/gb/book/9783319286204>

BOOKS 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! Water Resources - a new water architecture**, by Alexander Lane, Michael Norton and Sandra Ryan. 2017 Wiley Blackwell 328pp hbk
- ◆ **NEW! Gravel-Bed Rivers - processes & disasters**, by Daizo Tsutsumi & Jonathan Laronne (eds) 2017 Wiley Blackwell 798pp hbk
- ◆ **NEW! Archaeological Soil & Sediment Micromorphology**, by Cristiano Nicosia & Georges Stoops (eds) 2017 Wiley Blackwell 476pp hbk
- ◆ **NEW! Submerged Landscapes of the European Continental Shelf - Quaternary paleoenvironments**, by Nicolas Flamming et al., (eds) 2017 Wiley Blackwell 534pp hbk
- ◆ **NEW! The Protection & Conservation of Water Resources** by Hadrian F Cook (2nd Edn) Wiley Blackwell 437pp, hbk
- ◆ **NEW! Proterozoic Orogens of India - a critical window to Gondwana** by TRK Chetty. 2017 Elsevier 405pp, sbk
- ◆ **Sedimentology of Paralic Reservoirs - recent advances** by Hampson, G J et al., (eds) Geol Soc Publishing House 2017 SP #444 (hbk)
- ◆ **The Message - a novel** by Jan Vana. Falcondale press 199 pp sbk
- ◆ **Monogenetic Volcanism** by Nemeth K et al. (eds), 2017 Geol. Soc. pub. Hse., SP #446 382pp hbk
- ◆ **Earth System Evolution and Early Life - a celebration of the work of Martin Brasier** by Brasier A T et al (eds) 2017 Geol. Soc Pub. Hse. SP#448 432pp hbk
- ◆ **Subterranean Norwich - the grain of the city**, by Matthew Williams. Lasse Press 160pp sbk
- ◆ **Principles of Radiometric Dating** by Kunchithipadam Gopalan Cambridge UP 2017 207pp hbk
- ◆ **Geochemistry and Geophysics of Active Volcanic Lakes** by Ohba et al. GSL Publishing SP#437 295pp, hbk
- ◆ **Salt Tectonics - principles & practice** by Jackson PA and Huden MR. Cambridge University Press 2017 498pp, hbk
- ◆ **Chesapeake perspectives - decoding the deep sediments: Ecological History of Chesapeake Bay** by Grace Brush. 2017 Maryland Sea Grant 63pp sbk
- ◆ **Tectonics of the Deccan Large Igneous Province** by Mukherjee et al. (Eds), 2017. Geol Soc Spec Pub #445 363pp, hbk
- ◆ **Land Surface remote Sensing**, by Baghdadi N and Zribi M (eds). Elsevier 2017 342pp hbk
- ◆ **Integrated Environmental modelling to Solve Real World Problems. Geol Soc Spec pub #408, 2017** by Riddick et al (eds)
- ◆ **Petroleum Geoscience of the West Africa Margin. Geol Soc Spec. pub. #438, 2017** by Sabato Ceraldi et al (eds)
- ◆ **Waves, Particles and Storms in Geospace** by Balasis et al. 2016 Oxford University Press 448pp hbk
- ◆ **Lake Pavin - history, geology, biogeochemistry and sedimentology of a deep meromictic maar lake**, by Sime-Ngando et al., (Eds) 2016 Springer. 421pp, hbk

ENDORSED TRAINING/CPD

COURSE	DATE	VENUE AND DETAILS
Decoding Eurocode 7: Ground Investigation & Testing: Session 1 Geocentrix Ltd	2 November	Accessed online over 5 90-minute sessions on 2, 6, 9 13 & 20 November. Fees apply. See Website for details and booking. Venue: Higham Hall College, Bassenthwaite Lake, Cockermouth, Cumbria. Led by Dr Annette McGrath. Fees apply. See website for details and booking.

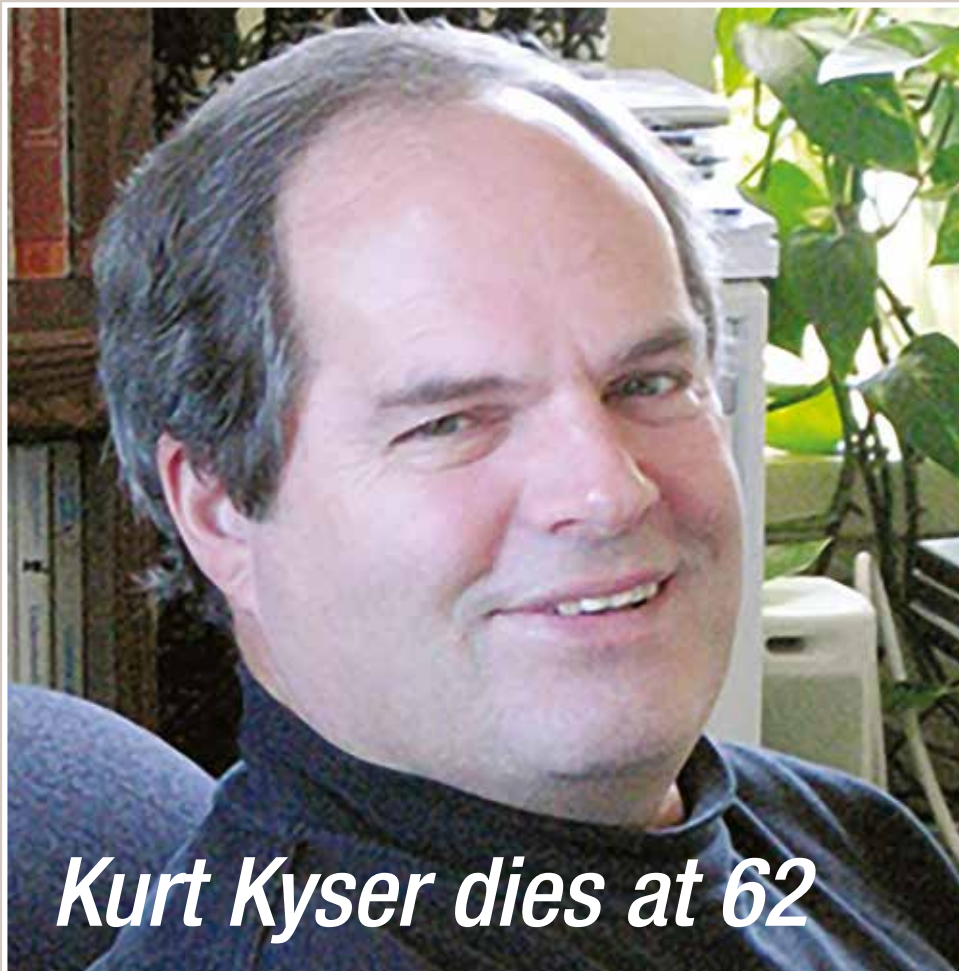
DIARY OF MEETINGS 2016/2017

PLEASE NOTE THAT THERE ARE MANY MORE MEETINGS FOR WHICH WE DO NOT HAVE SPACE.
ALWAYS CHECK WITH WWW.GEOLSOC.ORG.UK/LISTINGS

COURSE	DATE	VENUE AND DETAILS
Geology for Global Development: 5th Annual Conference Geological Society, GfGD	1-2 September	Venue: Burlington House. Topic: 'Cities: Opportunities and Challenges for Sustainable Development'. W: www.gfgd.org/conferences
Janet Watson Meeting 2017: The Future of Contaminated Land Risk Assessment; stakeholder perspectives Geological Society Contaminated Land SG	4-6 September	Venue: Burlington House. Fees & discounts apply – see Website for details and registration. Contact: Naomi Newbold E: naomi.newbold@geolsoc.org.uk
Cainozoic Clays of South East England South East Regional	6 September	Venue: Capita House, Wood Street, East Grinstead, West Sussex RH19 1UU. Time: 1800 for 1830. Contact: Simon Holt E: Simon.Holt@btp-hyder.com
Risk and Uncertainty in Exploration for Oil and Gas East Midlands Regional	7-8 September	Venue: Derby University DE22 1GB. Speaker: Malcolm Brown (President) Time: 1830 for 1900. Contact: Jessica DeFreitas E: jessica.defreitas@aecom.com
18th Glossop Medal Lecture Engineering Group	13 September	Venue: Royal Institution & Burlington House. Time: 1715 – 1800 (Reception @ BH) Charges apply for Reception. See website for details. Speaker: Jackie Skipper. Contact: Georgina Worrall E: georgina.worrall@geolsoc.org.uk
GSL Nottingham Careers & Industry Day 2017 Geological Society	13-19 September	Venue: BGS, Keyworth. An essential meeting place for geoscience students and the geoscience industry. Includes career and industry presentations covering different areas of geology and academia. See Website for details and registration. Contact: Naomi Newbold E: naomi.newbold@geolsoc.org.uk

STICKS AND STONES





Kurt Kyser dies at 62

The Society and Publishing House were saddened to learn of the sudden and untimely death of Kurt Kyser, writes Angharad Hills.

Fellow of the Royal Society of Canada and pioneering geochemist, Professor Kyser died while teaching in Bermuda on 29 August. Professor Kyser worked at the Department of Geological Sciences and Geological Engineering at Queen's University, Kingston Ontario. He was Chief Editor of the journal *Geochemistry: Exploration, Environment, Analysis*, which the Society co-publishes with the Association of Applied Geochemistry. The Society would like to extend its sincere condolences to his colleagues, friends and family.

➤ An obituary has been published in the Canadian Globe and Mail: <http://v1.theglobeandmail.com/servlet/story/Deaths.20170902.93392543/BDAS-tory/BDA/deaths>. Another obituary may be read at: <http://queensu.ca/geol/remembering-dr-kurt-kyser-0>.

Editor

IN MEMORIAM WWW.GEOLSOC.ORG.UK/OBITUARIES

THE SOCIETY NOTES WITH SADNESS THE PASSING OF:

Absolom, Sydney Stuart *
Armitage, John *
Atkinson, Keith *
Ayers-Morgan, Christopher *
Butcher, Norman Edward *
Chillingworth, Patrick Cecil Hamilton *
Collins, Michael Bernard
Coombs, Douglas *
Drysdall, Alan Roy *
Elueze, Anthony Azbuike *

Fischer, Alfred*
Gardener, Roger *
Garrard, Paul *
Geddes, James D*\$
Helm, Derick *
Howell, Frank Travis *
Jenner-Clarke, Hugh Clifford David *
Kelly, Desmond Michael *
Laws, Michael James *
Leighton, James *

Marshall, Mr John A *
Matthews, Peter Elvor *
Palmer, Stephen J *
Pipes, Kenneth P *
Rawcliffe, Eric *
Robson, David *
Shingleton, Sam *
Smith, Alan Gilbert *
Whitlow, Roy *
Young, Paul Ivor *

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

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

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





DISTANT THUNDER

Permanent memorials

As geologist and science writer Nina Morgan discovers some of the most moving war memories are set in stone

The appearance of war memorials marked one of the many changes to the British landscape brought about by the First World War. Bodies of the fallen were not repatriated, so many bereaved families were denied even the small comfort of a nearby grave on which to focus their grief. Instead, local groups formed committees to create war memorials to commemorate their dead. There are thought to be around 100,000 war memorials in Britain, around two-thirds of them from the First World War.

Local initiatives

In contrast to the war cemeteries established by the (then) Imperial, (now, Commonwealth) War Graves Commission, where the design of the memorials and headstones was strictly regulated (see War Graves Design by Committee got it Right, *Geoscientist*, 24.10, November 2014), decisions about erecting local war memorials was left to local committees. It was perhaps this outpouring of local grief and unregulated design initiatives that prompted the geologist Archibald Geikie [1835 – 1924] director of the Geological Survey from 1882 – 1901 and then retired and living in Haslemere, Surrey, to write to *The Times* on 10 June 1919.

In the course of his fieldwork in Scotland, Geikie became

interested in gravestones as means of studying weathering in stone, and was appalled at the speed with which certain stone types degraded (see The Wasting of Time, *Geoscientist* 25.9, October 2015)

In a letter to the Editor, headlined White Marble Unsuitable, Geikie wrote:

“Sir, As so many monuments are about to be erected all over the country in memory of those who have fallen in the war, it may be useful to give a word of advice as to the material that should not be chosen in the construction of them.

“On no account should white statuary marble be employed in any structure in the open air. Even the purest air of the country contains carbonic acid, which, dissolved in falling rain, acts on the stone as a solvent. In our rainy climate only a few years suffice to remove the polish from the surface, which gradually becomes rough and granular, so that one can wipe off the crumbling powder with the hand. In the air of large towns other acids, produced from the burning of coal are added to the atmosphere and increase the solvent action of the rain.

“Many years ago I studied this process of decay among graveyards in towns and in the country and as a result of my observations I found that in town air a marble monument freely exposed to air, rain, wind, and frost will seldom last as much as a hundred years ... Of course, a cynic may say that in the great majority of cases it will be no great matter if, at the end of a hundred years or less, a marble monument has fallen into ruins ... But our war memorials are meant to outlive generations, it is surely desirable that care should be taken to construct them of the most durable materials that can be obtained.”

Circumstantial evidence

The date of the letter, combined with personal connections, all suggest Geikie may have had something to do with the erection of the magnificent Grade II listed war memorial that graces the High Street in Haslemere. The gable-topped cross that tops the memorial was designed by the country house architect, garden designer and author, (Henry Benjamin) Inigo Triggs [1876 – 1923]. Triggs was also the designer of Broad Dene, a wonderful Arts and Crafts house situated near Geikie's own home in Hill Road, Haslemere.

Given his interests, Geikie may well have influenced the choice of stone. But what is the stone? From pictures, only two things are certain. Nearly 100 years after it was erected the Haslemere war memorial is still in excellent condition – and it is not made of marble!

Acknowledgement

I thank Julia Tanner, curator of the Haslemere Educational Museum for making local enquiries about the origin of the Haslemere war memorial on my behalf and passing on the helpful responses. Other sources include: a letter from Archibald Geikie to the Editor of *The Times* published on 10 June 1919; the websites www.learnaboutwarmemorials.org and www.warmemorialsonline.org.uk; and the Wikipedia and Dictionary of National Biography entries for Inigo Triggs.

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



OBITUARY John Baverstock Saunders 1928-2017

Saunders was born on 3 November 1928. He attended the Tiffin School in Kingston-upon-Thames and read geology at University College London, graduating with honours in 1951.

In the same year he took up an appointment with Trinidad Leaseholds Limited as a field geologist. In 1952 he was transferred to the geological laboratory in Pointe-a-Pierre. This proved an important career move as it brought him into contact with Hans Kugler, 'Father of Trinidad Geology' and who was instrumental in encouraging the use of planktic foraminifera for stratigraphic control. These studies were spearheaded by Hans Bolli and Walter Blow. Saunders was an enthusiastic addition to this team. These pioneering studies were among the earliest demonstration of the value of planktic foraminifera for stratigraphic correlation and later confirmed in other parts of the world. In 1959 John was promoted to Senior Stratigrapher.

Saunders' contribution to the geology of Trinidad over almost 25 years, was finally acknowledged by including his name in the Government's Roll of Honour, which recognises those who have made an exceptional contribution to Trinidadian life and called 'CARIBBEAN ICONS'. John was a worthy recipient.

Trinidad

As a consequence of the Suez Crisis, Texaco acquired Trinidad Leaseholds in 1956 and John spent the

Pioneer in the stratigraphic use of forams and major contributor to the geology of Trinidad



“ HIS CONTRIBUTION WAS ACKNOWLEDGED BY INCLUDING HIS NAME IN THE GOVERNMENT'S ROLL OF HONOUR AS A CARIBBEAN ICON ”

remainder of his working career with Texaco, retiring as Chief Stratigrapher in 1975. His responsibilities while initially confined to Trinidad later were extended to Texaco's exploration activities in Latin America. During this period he began a revision of the Kugler map, which was finally published in 1997. In 1975 he spent time

as the co-chief scientist on Leg 15 of the Glomar Challenger deep sea drilling project.

Other 'extracurricular' activities included producing a stratigraphic lexicon for Trinidad and Tobago, he co-coordinated the work of the Ministry of Energy who were ultimately responsible for publishing the revised geological map of the island. He was an honorary member of the Trinidad & Tobago Geological Society. In 1966 Saunders led excursions for the Canadian research vessel 'Hudson' on their visit to Trinidad and Barbados. He gave generously of his time to other things, including lecturing to university engineers. He was technical secretary for the 4th Caribbean Geological Conference, and chaired the

local branch of the Institute of Petroleum.

He took a keen interest in the Trinidad Field Naturalists' Club and was a Field Warden, and lectured to schools on their behalf. A keen ornithologist and a skilled pilot he was able to contribute material for French's book *Birds of Trinidad & Tobago* and to photograph the island's mud volcanoes.

Basel

Saunders retired in 1975, and accepted a position as curator of the micropalaeo collections in the Natural History Museum in Basel. This brought him, once again, in contact with his old mentor and colleague Hans Bolli, who was attached to the Federal School of Technology in Zurich. Here he co-curated the museum's micropalaeo reference collections. He led a government funded expedition to the Dominican Republic between 1978 and 1980. A major contribution whilst in Basel, was to co-edit with Bolli and Perch-Nielson the two volume book on Cretaceous-Tertiary planktonic foraminifera and also to co-author (with Bolli) the chapters on Oligocene-Holocene planktonics.

A lifelong bachelor, John finally retired, leaving Basel in 1994 and moving to Wensleydale in Yorkshire to enjoy a well-earned retirement. John died 5 January 2017.

► By Griff Cordey, with acknowledgement for material from Sally Radford and James Robson

OBITUARY Trevor David Ford 1925-2017

Trevor Ford, one of the giants of traditional British Geology and Senior Lecturer in the Department of Geology at Leicester University until he retired in 1987, died on 22 February aged 91

Essex

Trevor was born 19 April 1925 at Westcliffe-on-Sea in Essex. At 22 he went to Sheffield University to study geology, following his BSc with a PhD on the Ingleton and Stainmore Coalfields before coming to Leicester.

In 1952 he was appointed as an Assistant Lecturer at University College, Leicester to join Mac Whitaker. Between them they taught all branches of Geology up to the standard required by London University External Honours Regulations. As the department grew and the University was granted its Royal Charter, enabling conferment of its own degrees, his teaching was mainly in stratigraphy, palaeontology, micropalaeontology, map interpretation, quaternary geology, economic geology (mainly coal, oil and water-supply), environmental geology and the history of geological science.

Charnia

Trevor was well known internationally for his tremendous output on Derbyshire and elsewhere, but the aspect of his work that enjoyed greatest international impact concerned his description of the Precambrian fossil *Charnia*. This frond-like organism was found by a Leicester schoolboy, Roger Mason (himself later a well-known

Distinguished Leicester academic, describer of *Charnia*, speleologist and expert on Derbyshire geology



“TREVOR'S ACHIEVEMENTS WERE RECOGNISED BY A NUMBER OF AWARDS CULMINATING IN AN OBE IN THE 1997 QUEEN'S BIRTHDAY HONOURS LIST”

geologist), and described by Trevor in 1958. It was one of the first convincing organisms to be described from rocks that were incontestably Precambrian. *Charnia* and its relatives are now renowned as members of the enigmatic Ediacaran biota.

Trevor supervised 22 research students and examined a similar number of PhDs. He held visiting Professorships in both US and Australian Universities. He published over 500 papers, books, guides and reviews. He was promoted Senior Lecturer in 1980 and retired from the University in 1987, after 35 years' service. He was then given the title 'University Fellow' and maintained links with the Department, continuing his work on local geology, mining history, and caving.

Senate

He served the University extensively in numerous

capacities throughout his career. He was elected Honorary Editor of the Cave Research Group in 1964 (later the British Cave Research Association), and also of the Peak District Mines Historical Society in 1965. He held both posts until c. 1990 and was Chairman or President of both organisations. He was President of the East Midlands Geological Society from 1982-1985.

He was Hon Editor of the Transactions of the Leicester Literary & Philosophical Society from 1986 to 2000, and President of the Society in 1982. He was the series editor of the 'Limestone and Caves of...' books, of 'The Science of Speleology', and general editor of the Proceedings of the 7th International Congress of Speleology, 1977.

Honours

Trevor's achievements were recognised by a number of awards culminating in an OBE in the 1997 Queen's Birthday Honours List, for 'Services to Geology and Cave Science'. In 1974 he was awarded a moiety of the Lyell Fund by the Geological Society of London. In 2016 an honorary DSc was conferred upon him by the University of Derby in recognition of his contributions to the geology and landscape of Derbyshire.

Trevor's first wife Ann (*née* Thornhill) died in 1956. In 1958 he married Betty (*née* Thomas) who died in 2006. He is survived by his two daughters, Alison Tagg and Janet Baxter and his granddaughter, Kirsty Baxter.

► By Aftab Khan and Janet Baxter

OBITUARY James Brooks 1938-2017

James Brooks, known as Jim, was as proud of his Saltaire, Bradford, and Yorkshire upbringing and schooling (Salt Grammar School 1950–58) as anyone could be; but he was actually born in Co. Durham. Football and cricket, both playing and watching were life-long passions.

After a year working for ICI in Billingham, in 1959 he entered the Industrial Chemistry Honours course of what became Bradford University in 1966. His interest in organic chemistry began with an undergraduate BTech study of the chemistry of wool grease, followed by an MPhil on wool wax and then a PhD (Bradford, 1969) on the chemistry of sporopollenin (on which he became an authority) which makes the highly resistant walls of pollen, spores and microorganisms and is the commonest fossil even in the Precambrian.

Chemical palynology

He became a research chemist in chemical palynology with BP (1969–75), including exploration work on samples from the North Slope, Alaska and the North Sea. He became FGS in 1974. He returned to Bradford University as a Senior Research Fellow (1975–77), working on extant and geological organic materials before joining the British National Oil Corporation in Glasgow in 1977 as Head of Geochemistry, leaving as Senior Scientist in 1986 to form Brooks Associates as a consultant.

Outstanding organic geochemist and lecturer, who founded the Society's Petroleum Group



“THE SOCIETY REMEMBERS HIM FOR FOUNDING THE ‘PETROLEUM GEOCHEMISTRY GROUP’, WHICH BECAME THE PETROLEUM GROUP, OF WHICH HE WAS FIRST CHAIR”

By then he had researched organic matter in meteorites and the origin of life, published over 50 papers and six books, and lectured and consulted through the

UK, Europe, North America, India and USSR - being UK Exchange Scientist to USSR (1971) and Royal Society Visiting Scientist to India in 1977.

From 1986 he gave short courses literally all over the world because Jim was a superb lecturer, giving an annual organic geochemistry course to Glasgow University geologists (1978–98) but he also teaching Glasgow Chemists and Strathclyde Applied Geologists. He was AAPG Distinguished Lecturer to North America (1989–90).

Petroleum Group

The Society remembers him for founding the Petroleum

Geochemistry Group in 1979 which, in 1981 became the enormously successful Petroleum Group with Jim as Founder and First Chairman. He initiated the Society's agreement with the AAPG to mutually sell each other's publications and played a leading role in the Petroleum Geology of NW Europe Barbican conferences and resulting books.

He was elected to Council in 1984, was a Vice President, and then Secretary from 1987–90. He received awards for Distinguished Achievement from the AAPG (1993) and Service from the Society (1999) and a Bradford University DSc (2001).

Faith

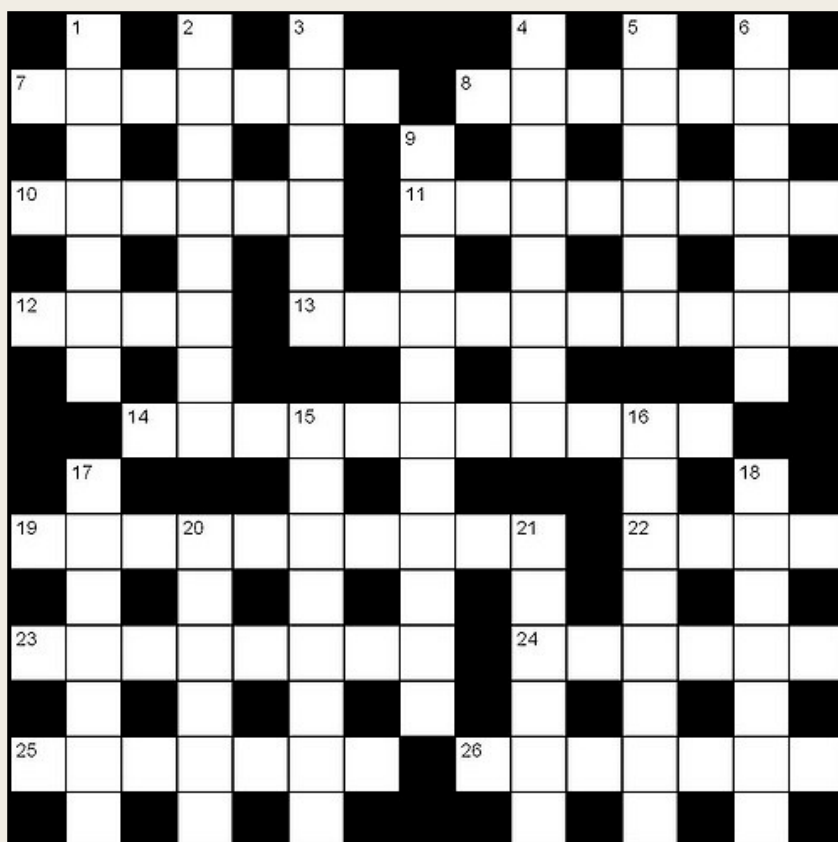
Jim's Christian faith and church-led community service was at his core, whether in Yorkshire or Glasgow and he became a near full-time Secretary of the burgeoning Queens Park Baptist Church, Glasgow, for a decade ending in 2002–3 when he was the last President of the Baptist Union of Scotland. He was utterly reliable, good company and splendid teacher.

He retired to Cumnock, Ayrshire, and wrote a 725 page 2013 autobiography *The Full Spectrum* which is in the Society's library. He leaves Jan, his wife of 43 years, Naomi, Daniel, and four grandchildren.

➤ By Bernard Elgey Leake

Editor's Note – a longer version of this obit can be read online.

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.220 SET BY PLATYPUS**ACROSS**

- 7** Type selected subsequently to the description, to replace another (7)
8 GSL founder who invented the cage, among other leccy things (7)
10 Adjustable monkey, pipe or torque (6)
11 Hemlock-drinkibng corrupter of youth (8)
12 Triangle a long way from anywhere (4)
13 Element of the D-block (10)
14 Water-loving chemical species (11)
19 Not your immediate forebear's sister, but one who came before at least (10)
22 Double-reeded wind instrument of the orchestra (4)
23 Fish-like marine chordate of the order Amphioxiformes (8)
24 Dig up a Scottish enlightenment philosopher (6)
25 'Difficult' years (7)
26 Under the drift (7)

DOWN

- 1** Turn terrifyingly to rock (7)
2 A cartilaginous fish related to sharks, in the suborder Myliobatoidei (8)
3 In consequence; goes a bit ballistic (6)
4 Jonquils named for Housman's Grecian lad (8)
5 Basic eruptive (6)
6 Arthur's seat. Or possibly JFK's. (7)
9 Steeper slope of a cuesta (11)
15 Science of non-Newtonian fluid flow (8)
16 Line of equal-drilled thickness of a rock unit (8)
17 Drives to frenzied anger (7)
18 Hibernating rodents much eaten by fancy Romans (7)
20 'Dawn of the recent' (6)
21 Basal, asymptotic portion of cross-lamination (6)

WIN A SPECIAL PUBLICATION!

The winner of the September Crossword puzzle prize draw was **Conor O'Malley of Cambridge**.

All correct solutions will be placed in the draw, and the winner's name printed in the February 2017 issue. The Editor's decision is final and no correspondence will be entered into.

Closing date - December 8.

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 SEPTEMBER**Across:**

- 7** Vesicle **8** Methane **10** Uplift
11 Exposure **12** Miro **13** Spherulite
14 Meteorologist **19** Landscaped **22** Agar
23 Portland **24** Ablate **25** Peonage **26** Pinnate

Down:

- 1** Leipzig **2** Silicone **3** Slates **4** Leapfrog
5 Chisel **6** Ingrate **9** Cephalopods/a
15 Recharge **16** Scabland **17** Halogen
18 Cantata **20** Dating **21** Diapir

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Career & Industry Days 2017

The Geological Society

Wednesday 8 November 2017
Venue: BGS, Keyworth, Nottingham, UK
www.geolsoc.org.uk/careersday17nottingham

Wednesday 22 November 2017
Venue: Our Dynamic Earth, Edinburgh, UK
www.geolsoc.org.uk/careersday17edinburgh

The Geological Society Career & Industry Day is an essential meeting place for geoscience students and the geoscience industry, and is the most recognised geoscience careers focused forum in the country.

The day will include short career and industry presentations covering different areas of geology and academia, and there will be an exhibition consisting of industry and professional bodies, and higher education institutions promoting MSc and PhD programmes. There will also be a CV and careers workshop running alongside the talks.

Registration
This event is free to attend but there are limited numbers so pre-booking is recommended. Delegates will be required to pre-register to receive a student manual, free packed lunch and free drink at the drinks reception.

Contact Information
Naomi Newbold, Conference Office,
The Geological Society, Burlington House,
Piccadilly, London W1J 8BG
T: 0207 432 0985
E: naomi.newbold@geolsoc.org.uk
Follow these events on Twitter: [PGS Careers17](https://twitter.com/PGS Careers17)

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Lyell Meeting 2018

Mass extinctions: understanding the world's worst crises

7 March 2018

The Geological Society, Burlington House

The study of mass extinctions is one of the most interdisciplinary research areas within Earth and environmental sciences. Recent major advances have come from a broad spectrum of fields including atmospheric modelling, high-precision age dating, volcanology, geochemistry, stratigraphy and palaeontology. The 2018 Lyell Meeting aims to highlight these achievements and showcases the improved understanding we now have of the great environmental catastrophes of the past. The Meeting aims to encompass the full spectrum of crises seen in the Phanerozoic fossil record.

The 2018 Lyell Meeting provides a platform to assess the current stratigraphic and geochemical records of environmental change during mass extinction events and the role of atmospheric climate modelling in understanding the causes of the crises. The goal is to evaluate the relative importance of environmental changes in major episodes of species extinctions, and to further explore the mechanisms that link these proximal kill mechanisms to the ultimate drivers, such as large igneous province eruptions and meteorite impacts. This will be a rare opportunity to hear research developments happening in diverse disciplines applied to all mass extinction events.

Convenors:
Paul Wignall (University of Leeds, UK)
Dave Bond (University of Hull, UK)

Keynote Speakers:
Prof Mike Benton (University of Exeter)
Dr Sofia Lindström (Geological Survey of Denmark and Greenland)

Further information:
For further information about the conference please contact:
Naomi Newbold, Conference Office, The Geological Society, Burlington House, Piccadilly, London W1J 8BG
T: 0207 432 0944
E: naomi.newbold@geolsoc.org.uk
Web: www.geolsoc.org.uk/lyell18
Follow this event on Twitter: [lyell18](https://twitter.com/lyell18)

Call for Abstracts:
We invite oral and poster abstract submissions for the meeting, and these should be sent in a Word document to naomi.newbold@geolsoc.org.uk by 1 December 2017. Abstracts should be approximately 250 words and include a title and acknowledgement of authors and their affiliations.



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