GEOSCIENTIST

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The Fellowship Magazine of the Geological Society of London

@geoscientistmag

NICK ROGERS SIGNS OFF AS PRESIDENT

SANDBOX SCIENCE

Sian Evans on a novel use of technology to research subterranean salt giants

FRIEND OR FOE?
Ted Nield reflects on our attitudes to nature and the 'natural'

STRENGTHENING GEOSCIENCE
Global partnerships between geological organisations

HOME SCHOOLING
Pete Loader has resources for teaching geology from home

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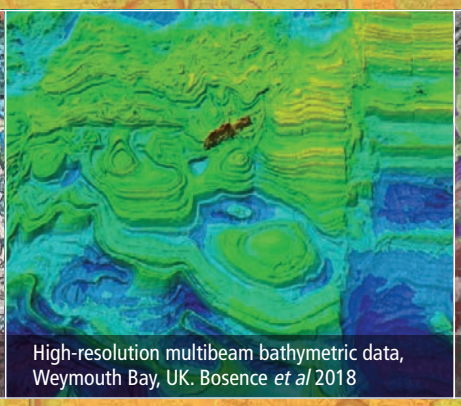
TSG
Tectonic Studies Group of the Geological Society

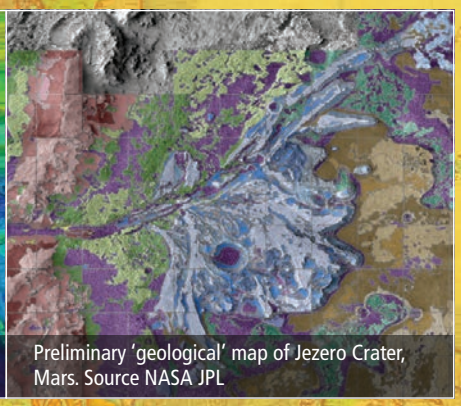
WILLIAM SMITH MEETING 2021

Geological mapping: of our world and others

19-21 October 2021 | **The Geological Society, Burlington House, London**


Part of 1" map by Geological Survey of Scotland, 1892, NW Scotland


High-resolution multibeam bathymetric data, Weymouth Bay, UK. Bosence *et al* 2018


Preliminary 'geological' map of Jezero Crater, Mars. Source NASA JPL

Map-making is a fundamental tool for developing geological knowledge. This 3-day conference is a celebration of geological mapping, its historical importance and future directions, and its use to deduce Earth and planetary evolution and processes in its wide context. The program seeks to explore Earth's surface to subsurface realms, and beyond to extra-terrestrial bodies.

Confirmed Keynote Speakers

Kathryn Stack (Jet Propulsion Laboratory, NASA)
Marc St-Onge (Geological Survey of Canada)
John Dewey (University College, Oxford)
Mike Daly (President-designate of the Geological Society)

Convenors

Lucy Williams (Rockhopper Exploration)
Rob Butler (Aberdeen University)
Mike Searle (University of Oxford)
Sanjeev Gupta (Imperial College)
David Schofield (BGS)

Further information

For further information about the conference please contact:

Conference Office,
The Geological Society,
Burlington House,
Piccadilly, London W1J 0BG
T: 0207 434 9944
E: conference@geolsoc.org.uk
Web: www.geolsoc.org.uk/wsmith21

Follow this event on Twitter: #wsmith21

Call for Abstracts

We invite oral and poster abstract submissions for the meeting, and these should be sent in a Word document to conference@geolsoc.org.uk by 30 April 2021. Abstracts should be approximately 250 words and include a title and acknowledgement of authors and their affiliations.

The Geological Society
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2021 YEAR OF SPACE

Geoscientist is the Fellowship magazine of the Geological Society of London

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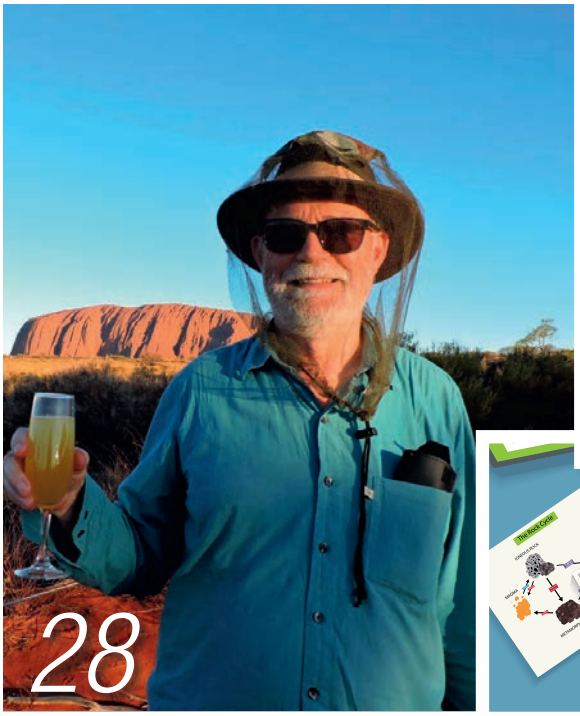
Cover image: The beach of Scala dei Turchi at sunset. ©Shutterstock Lucas Gatto



ON THE COVER:

10 SUBTERRANEAN SALT STRUCTURES AND SANDBOX SCIENCE
Sian Evans reports on a novel use of technology to investigate the structure of subterranean salt giants

FEATURES

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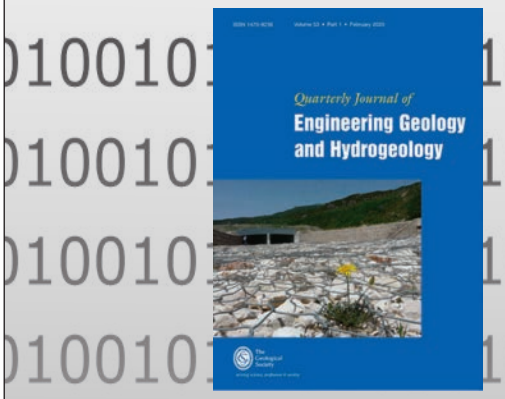


For full information visit the Lyell Collection:

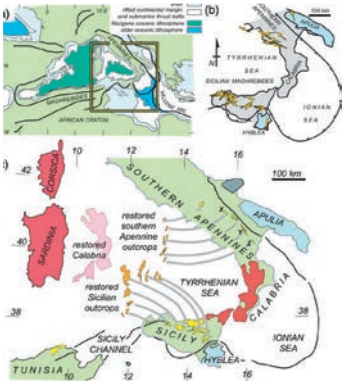
www.lyellcollection.org/cc/digitization-and-digitalization-in-engineering-geology-and-hydrogeology

Latest news from the Publishing House

Deep-water sand-fairway mapping as a tool for tectonic restoration: decoding Miocene central Mediterranean palaeogeography using the Numidian turbidites of southern Italy

By Robert W.H. Buter, Patricia R. Pinter, Rosanna Maniscalco and Adrian J. Hartley

As turbidity currents are sensitive to the geometry of the substrate across which they flow, the sedimentology of turbidites can chart the development of submarine structures and reveal regional palaeobathymetric connections. This rationale is applied to understand the tectonic evolution of the central Mediterranean in the early Miocene, using the African-sourced, hyper-mature Numidian sandstones and their immature, orogen-derived time-equivalents. In both Sicily and the southern Apennines, the Numidian sequence displays characteristics of confined–uncontained turbidites: grain-size breaks and coarse bedload indicative of ubiquitous flow bypass; short-range grain-size fractionation across flow; stacked sandy bed-sets in the flow axes...

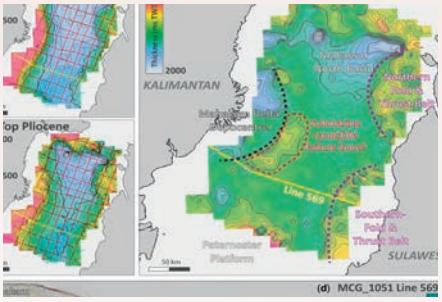


➤ **Read the full abstract and paper in the Lyell Collection**
https://jgs.lyellcollection.org/content/early/2020/04/08/jgs2020-008

Indonesian Throughflow as a preconditioning mechanism for submarine landslides in the Makassar Strait

By Rachel E. Brackenridge, Uisdean Nicholson, Benyamin Sapiie, Dorrik Stow and Dave R. Tappin

The Makassar Strait is an important oceanic gateway, through which the main branch of the Indonesian Throughflow (ITF) transports water from the Pacific to the Indian Ocean. This study identifies a number of moderate (>10 km3) to giant (up to 650 km3) mass transport deposits within the Makassar North Basin Pleistocene–Recent section...



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> IN MOMENTS OF CRISIS, KEEPING IN TOUCH IS ALWAYS AT THE FOREFRONT OF OUR MINDS

FROM THE EDITOR'S DESK:

KEEPING IN TOUCH

I don't know about you, but I am drowning in video calls. I'm not sure I'd even heard of Zoom before this all began (what feels like approximately 250 years ago), but now it is the perpetual calendar appointment, popping up on my phone with the regularity of my current handwashing routine.

With it has come various bits and bobs of advice about how to avoid something called 'Zoom burnout.' According to psychologists, constantly paying attention to our fellow video callers' body language and social cues can leave us anxious and stressed. (I would add to that, the constant fear that you might have left a pile of washing or last night's leftovers in the background.) Advice for combatting 'Zoom burnout' is fairly straightforward: try to limit calls to those strictly necessary, and consider only switching on your audio for some meetings – especially those which would have been conference calls to begin with.

There's no doubt that the benefits outweigh the drawbacks – in the past few weeks I've managed to keep in touch with friends and colleagues all over the world. Video conferencing is also keeping conference and events programmes going – an interesting experiment which might lead the way to widening access to such events in future. As I write, the European Geosciences Union (EGU) is holding its 2020 General Assembly remotely as 'EGU2020: Sharing Geoscience Online' – what is usually a meeting bringing together around 16,000 geoscientists in one place has been replaced by a diverse programme of online scientific sessions, symposia, debates and meetings. Meanwhile, some of the Society's own offerings have been transferred online – including this months' public lecture (more details at www.geolsoc.org.uk/events.)

In moments of crisis, keeping in touch is always at the forefront of our minds. In 1941, with the blitz underway and the Society's premises at Burlington House suffering from bomb damage, a decision was made to evacuate over 8,000 books (over a third of the total stock) from the Library's collections. 'It is desired to effect some dispersal of the books in order to reduce the risk of loss by enemy action' was the appeal to Fellows, who stored them in basements and attics across the country. It was still possible, though, to borrow volumes.

'A system of paper and string was brought into action' recalled Nancy Morris, the Society's Clerk from 1940 to 1962. 'The Fellow requiring the books was told to write to the Fellow who had it evacuated who with paper and string supplied by us, sent it to the one who wanted it and he returned it direct, so none of these books came back into London.'

I find that story, geologists posting books in pre-supplied paper and string around the country so that their studies continued uninterrupted, strangely comforting. A reminder that our networks still exist, even when we can't meet in person.

With that in mind, don't forget that alongside your video conferences and online meetings, you can always employ the relatively low tech communication method of writing to Geoscientist magazine – our letters page is always open for contributions, and there's no risk of Zoom burnout to boot.

Sarah Day FGS, EDITOR - sarah.day@geolsoc.org.uk @geowriter @geoscientistmag

SOCIETY NEWS

SOCIETY BUSINESS

2022 – THE YEAR OF SUSTAINABILITY

The Society's theme for 2022 has been announced, writes Alicia Newton.

We're pleased to announce that 2022 will be the Geological Society's Year of Sustainability. Throughout the year, we will explore the role geologists have to play in delivering the energy transition and the UN's Sustainable Development Goals (SDGs) through a variety of research conferences, lectures and education and outreach activities.

"One of the great challenges of our time is to move our mind set from exploring and exploiting our planet to exploring and sustaining life on it' says President-designate Mike Daly. "To this end, the UK Government and many of the UK's major industries have set aggressive targets to achieve net zero carbon emissions. This pivot away from a carbon based society presents many opportunities for the Earth sciences: from mitigating climate change impacts to exploring for geothermal energy and the key energy transition metals such as copper, cobalt and the rare earth minerals, as well as enabling the secure and economic storage of carbon and radioactive waste."

Joel Gill, the incoming Secretary of Foreign and External Affairs and Executive Director of Geology for Global Development, says "The responsible management and extraction of natural resources such as minerals and water, together with an improved understanding of natural hazards, are major components of meeting many of the SDGs. The Year of Sustainability will allow the Society to bring together scientists, community leaders and policy makers to ensure that economic development is underpinned by environmental stewardship and empowered communities."

The Society's thematic year programme aims to raise the profile of geoscience, promote public engagement and provide exciting and informative themes around which to frame our education, outreach, publications and conference programmes.

The Society has long argued that geologists hold the skills and knowledge needed to ensure the world can meet targets for reducing carbon emissions and fully support a growing population, whilst protecting the natural environment. We're looking forward to showing students, educators, communities and policy makers just how much geology has to contribute to ensuring the future wellbeing of people and the planet.

Get involved!

We're planning to run activities during the Year of Sustainability to highlight geology's role in ensuring a sustainable future for all, and we want to hear your ideas and proposals for:

- Meetings and conferences
- Education and outreach activities
- Public engagement initiatives

We are aiming to run a diverse programme of events which could include exhibitions, presentations, scientific conferences, resources for teachers and science communicators, artistic collaborations and more! You can also continue to submit ideas and proposals for the 2021 Year of Space.

Email Alicia.Newton@geolsoc.org.uk to discuss your ideas with us.

See our website for past examples and details of how to propose an event, or email conference@geolsoc.org.uk.

PRESIDENT'S DAY AND ANNUAL GENERAL MEETING 2020

Fellows are aware that, at the time of writing, the Society's offices are closed due to the Covid-19 pandemic. Council agreed at their April meeting to decouple the formal business of the AGM from President's Day, which is cancelled. It is very much hoped to have an event later in the year but this is entirely dependent on the situation in the UK with regard to Covid-19.

The AGM will go ahead on 4th June as a virtual meeting so that the formal business of the Society can be conducted. All Fellows for whom we have e-mail addresses and who are eligible to vote received information about the AGM during May. If you have a query about the AGM please contact Stephanie.jones@geolsoc.org.uk

THE GREAT GEOBAKEOFF IS BACK!

Every year, we set a series of geobaking challenges on our blog (blog.geolsoc.org.uk). This year's competition is slightly different – given that so many of us are unable to leave our homes, let alone find flour and eggs when we do, this year's Bake Off is also a Make Off! If you can't bake it, make it instead – using whatever you have available.

Challenges range from the ever popular GSL rock pets to dinosaur brains (yes, really). This year, we've also teamed up with the Micropalaeontological Society for a special microfossils challenge. Prizes are awarded in a variety of categories, including Junior Baker, Master Baker and – new for 2020 – the Thrifty Shopper Award for creative use of household items.

You can send us your entries via Twitter, Instagram or Facebook using the hashtag #geobakeoff (remember to tag @geolsoc), or if you're not using social media, email us at outreach@geolsoc.org.uk. The deadline is **15 June 2020** – good luck!

What your society is doing
at home and abroad

SOCIETY BUSINESS

ONLINE EDUCATION RESOURCES

The Society has a wealth of education resources available on our website, which might be particularly useful to those currently teaching at home. All are available via our education resources homepage (www.geolsoc.org.uk/heresources) and include:

- Animations and interactive quizzes on our online learning modules: KS4-5 Plate Tectonics and KS3-4 Rock Cycle
- Factsheets on a variety of subjects including volcanoes, the rock cycle, fossils, earthquakes, energy resources and dinosaurs. Great for some extra subject knowledge or extended reading, and available in primary and secondary level versions
- Downloadable activity sheets – make your own volcano, test out different lava speeds, build an earthquake resistant building or battle out different energy resources! (Available in primary and secondary level versions)
- Research future university and career options in geoscience through our Geology Career Pathways module
- Primary students can listen to our 'Fun Kids Radio' podcasts on lots of different Earth science topics covering volcanoes, different rock types, Earth history and more!

In addition, A-level students might enjoy our online public lecture series, available to watch on YouTube (www.youtube.com/GeologicalSociety) – a great way to increase geological knowledge on topics like climate change, natural hazards and the carbon cycle.

CORONAVIRUS UPDATE

Due to the ongoing public health risk posed by COVID-19 and the consequent closure of the Geological Society, all GSL events and venue hire bookings through to the end of June are being postponed or cancelled in line with Government advice. Please check our events page (www.geolsoc.org.uk/events) for up to date information. The Society's offices were closed from 17 March onwards – please check online for the latest updates.

PUBLIC LECTURE SERIES

Virtual Public Lecture: Strategies in times of crisis: lessons from past marine ecosystems

Speaker: Daniella Schmidt, University of Bristol
Location: Online
Date: 23 June 2020

Professor Schmidt will explore historical and geological records of the response of marine ecosystems to environmental change, and give examples of the information that palaeontologists can contribute to the global challenge of estimating the impacts of climate change.

Further information

A joint public lecture with the Linnean Society. This talk will be taking place online, with further details on how to view available on our website at **www.geolsoc.org.uk/strategiesintimes**.

Contact: **conference@geolsoc.org.uk**

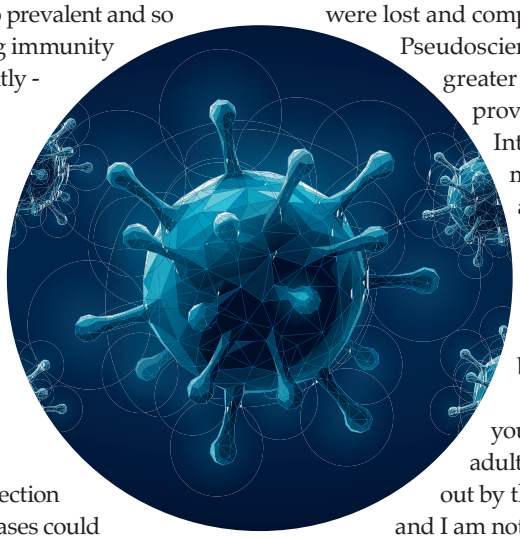
Contact: The Geological Society, Burlington House, Piccadilly, London W1J 0BG
T: **+44 (0) 20 7434 9944** E: **conference@geolsoc.org.uk**

Nature is not your friend

Photograph by Dr Jeffrey Williams

As the Geological Society's Year of Life is dramatically brought to a standstill by a life form, **Ted Nield** reflects on changing attitudes to nature and the 'natural'

I was born in 1956. People of my generation, like the 'boomers' before them and all previous generations too, regarded nature as something principally to be feared - and it isn't hard to understand why. We were used to the idea that nature provided us with a bounty that included regular seasonal and non-seasonal infections to which we were going, inevitably, to be exposed, and which we were expected to have to contract naturally as part of the passage to adulthood. Indeed, many of these infectious agents were so prevalent and so contagious that acquiring immunity was positively – and rightly - encouraged. Measles, mumps, rubella and chicken pox appeared regularly and inevitably, and everyone knew that early exposure would not only confer immunity, but would likely have less serious long-term consequences for having taken place early in life. Our parents sometimes organised infection parties so that these diseases could be shared out.



CLASSMATES

We remember also that some of our classmates never came back to school after this experience. I remember one who died, aged about seven, from measles. We also remember other schoolmates wearing leg-irons as a result of polio, and how the NHS of the time struggled to find the resources for the iron lungs that were needed in those cases where polio infection resulted in damage – usually, but not always temporary – to the autonomic reflex that controls breathing. Lord Nuffield turned over the resources of his motor car manufacturers to meet this the unprecedented demand, which is why owners of Morris Minors recognised some of the components as their children were inserted into these machines for a period of uncertain length.

To us, then, nature was something not only to be treasured, but also feared. Not everything in nature was good for you. Quite a lot of nature was out to get you.

INFORMATION AND MISINFORMATION

The reality of this situation has not changed; but thanks to new vaccines, in later years many lives that would otherwise have been lost or permanently blighted, were saved. And with that, memories of nature's many dangers were lost and complacency set in.

Pseudoscience, abetted by the greater availability of lies provided thanks to the Internet (a wonderful means of education, but an even better one for the dissemination of misinformation) sought to discredit the very thing that had been saving us.

People tell me that the younger generation of adults is now feeling freaked out by the present pandemic, and I am not surprised. Nothing in their experience, or those of their parents, has prepared them for this. They have grown up with the idea that nature is universally benign. What's more, they are bombarded with information (and misinformation) about the pandemic as never before.

A FORMIDABLE ENEMY

There will be – and should be – many reckonings once this emergency is past. But let us not forget this one. Nature is not your friend. Nature has to be resisted and fought as well as nurtured. Nature can also be the enemy, and a formidable one. And as things that were frozen thaw out, and the rainforests disgorge their displaced faunas and bring them into contact with humans for the first time, let us remember that caring for nature and fearing it are two sides of the same coin.

Ted Nield was formerly Editor of Geoscientist

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 **sarah.day@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).

> "THE YOUNGER GENERATION... HAVE GROWN UP WITH THE IDEA THAT NATURE IS UNIVERSALLY BENIGN"
>
> **TED NIELD**

The Geological Society

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15 March 2021

Plastics in the Environment

The Geological Society, Burlington House, London

Primary Convenors

Wes Fraser (Oxford Brookes University)

Gordon Inglis (University of Southampton)

Further information

For further information about the conference please contact:

Conference Office,
The Geological Society,
Burlington House, Piccadilly,
London W1J 0BG

T: 0207 434 9944

E: conference@geolsoc.org.uk

Web:
www.geolsoc.org.uk/plastics2021

Follow this event on Twitter:
#plastics2021

The accumulation of plastic debris in the environment is a global problem which may have detrimental impacts on ecosystem health. Plastics are now widely enough distributed that they may also act as an anthropogenic marker horizon in the future rock record. However, there are still many outstanding questions regarding the: 1) source, 2) transfer, 3) degradation, 4) persistence and 5) measurement of plastics in the environment.

This one-day meeting will bring together researchers from a diverse range of disciplines (e.g. hydrology, sedimentology, geochemistry, earth science, biology) to discuss the fate of plastics in terrestrial, freshwater and marine environments.

This meeting seeks to foster conversation between these different communities to facilitate a more holistic approach towards understanding plastic in the environment.

SUBTERRANEAN SALT STRUCTURES AND SANDBOX SCIENCE

Sian Evans on how a CT scanner is helping to understand subterranean salt giants

Panoramic view of the blindingly white sandstone cliff of Scala dei Turchi, a marl formation deposited during the final stage of the Messinian Salinity Crisis. Shaped like a giant staircase, it is named after the Turk priates that used to hide in the cove

It was a drizzly, grey morning when I arrived in the suburbs of Paris, sluggish from catching the first Eurostar at the crack of dawn but excited for the challenge ahead. I navigated my way through the windy streets in search of IFP Energies Nouvelles (IFPEN) - a renowned research organisation specialising in applied geoscience for the energy industry, which houses a dedicated lab for physical analogue modelling.

A myriad of models

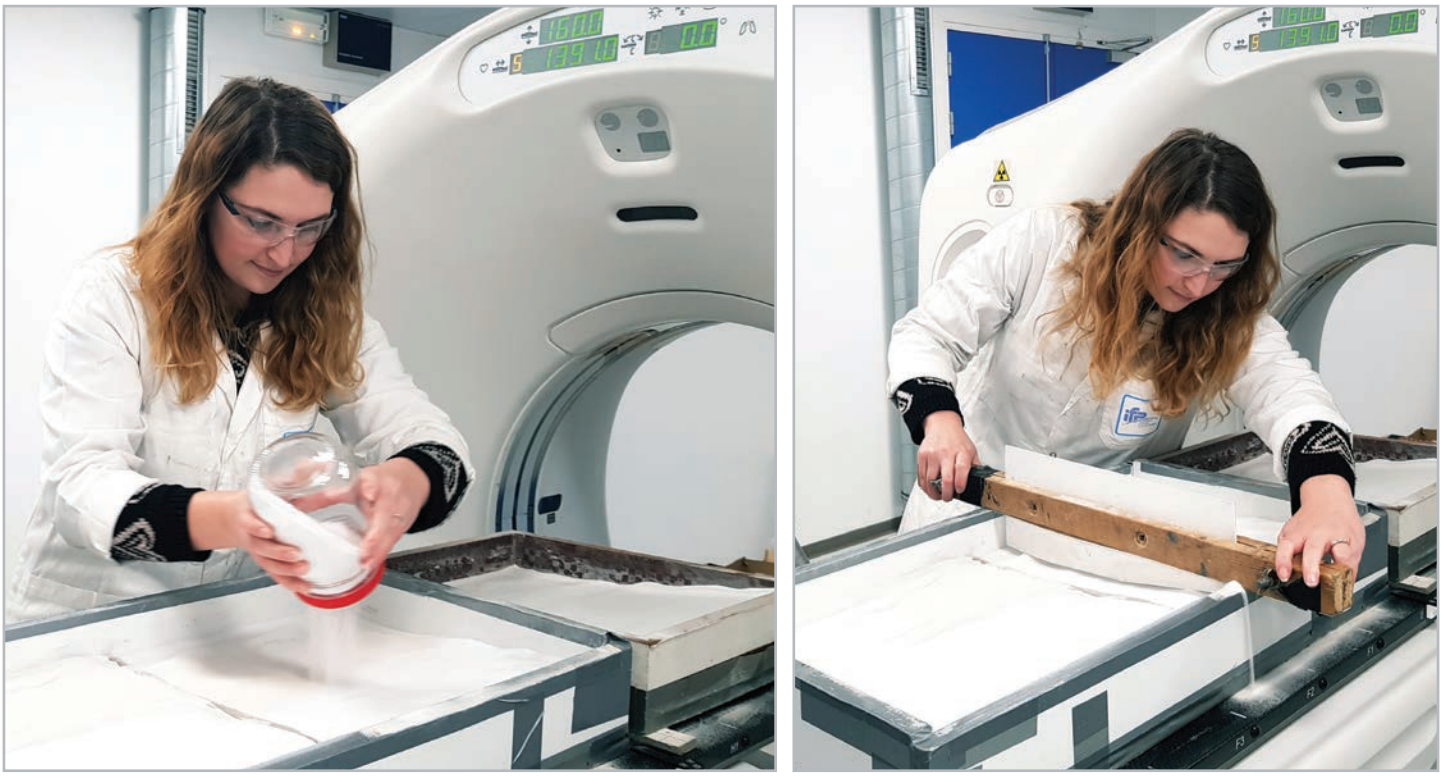
During the previous year I had designed several models to test some of the ideas I was developing as part of my PhD at Imperial College in London. Thanks to generous grants awarded to me by the Geological Society and AAPG, I was given the opportunity to run some of these models within the specialist lab at IFPEN.

In the 21st century, an era of data abundance and ever-increasing computational power, models - simplified descriptions of a system or process, to assist calculations and predictions - have a myriad of applications. We have models predicting everything, from the weather, the traffic and the growth of the economy, to which posts you're most likely to engage with on social media and how you're going to vote in the next election. Models seem to be taking over. But my models are not trying to predict the future - they're trying to see into the past.

Salt giants

Let's take a step back. My PhD is in the field of salt tectonics. One of the unique properties of salt is that it flows like a fluid over geological timescales, creating extremely complex deformation patters. Thick salt deposits are buried in many sedimentary basins around the world and my research investigates the significant impact such deposits have on the structural development of those basins.

These subterranean salt giants can be absolutely enormous -take the Mediterranean, for example. At present the Med is connected to the open ▶



Analogue modelling in action: applying additional sand layers at certain time intervals during model runs (left), and ensuring even distribution of sand layers (right)

► waters of the Atlantic via a narrow passage through the Gibraltar Straits, but around 6 million years ago this connection was disrupted. The Med became an isolated body of water, and intense evaporation caused water levels to drop. As more and more water was evaporated the salinity of the remaining seawater increased, until salt started to precipitate and settle on the seafloor. This dramatic event is known as the Messinian Salinity Crisis, and it led to the deposition of the world's youngest salt giant – a thick unit of salt deposited across the Mediterranean basin.

Today, these salt giants are not only under water but also buried beneath several kilometres of sand, which means we need to use geophysical techniques to study them. The most common of these utilises seismic data; sound waves which travel through the subsurface, reflect off internal boundaries within the rock and are received back at the surface. These waves are then used to create an image of the subsurface. Using this method, we can see underground faults, folds and other structures that would otherwise be invisible to us.

Sandbox science

Seismic data is a powerful tool for subsurface exploration, but it only reveals what the deformed rock looks like at the present day. How did these structures form? Which factors controlled their development? That's where the modelling comes in. Modelling is particularly useful in this case as we are dealing with processes that take place over millions of years and thousands of kilometres. In order to observe these in action on human scales, we have to condense that down to a matter of hours and centimetres. We do this by creating a scaled down replica of the system – a physical analogue model.

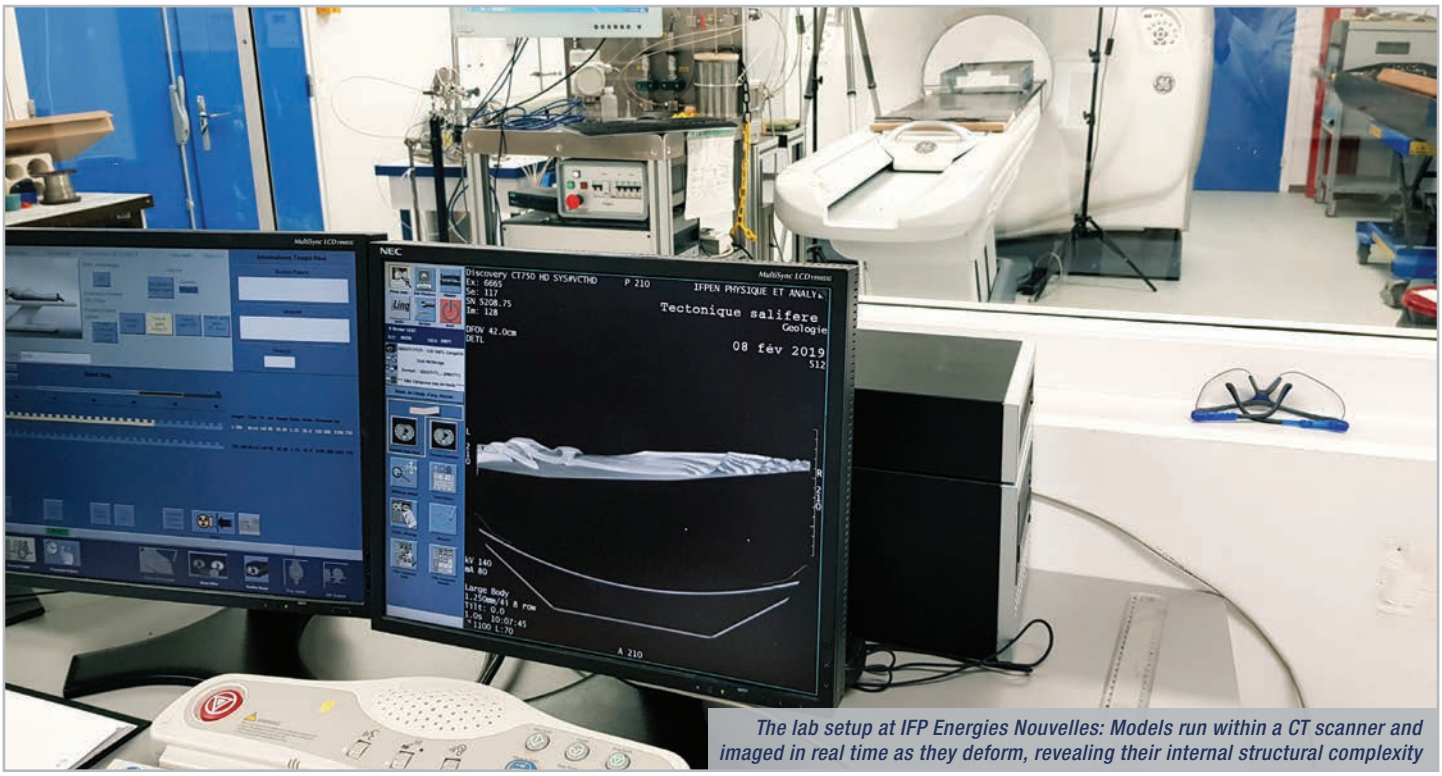
First, we have to scale down the physical properties we're working with, such as the viscosity of the salt, the cohesive strength of the overlying rock and the sedimentation rate. All these parameters must be scaled down proportionally, otherwise our model will not physically represent the natural system. We use silicone to represent the salt layer; a liquid viscous enough for you to hold in your hand but which will slowly seep through your fingers. Loose sand layers represent the overburden rock, with additional sedimentary layers added at certain time intervals as the model progresses.

Physical analogue models are therefore informally known as sandboxes, but it's not quite as playful as it sounds!

One rather unique advantage of the IFPEN lab is that they possess a CT scanner in which they can run the models. This is exactly the same type of medical scanner used in hospitals to acquire brain scans and body scans. In fact, it was bought second hand from a hospital. The scanner enables us to see what is happening inside the model as it runs - otherwise, we would only be able to monitor the deformation of the surface or sides as it deforms, and would have to cut up the model at the end to look inside. This way, there is no need to slice it open, and we can image it internally in real time to acquire a full 4D evolution of the model.

Surface geometry

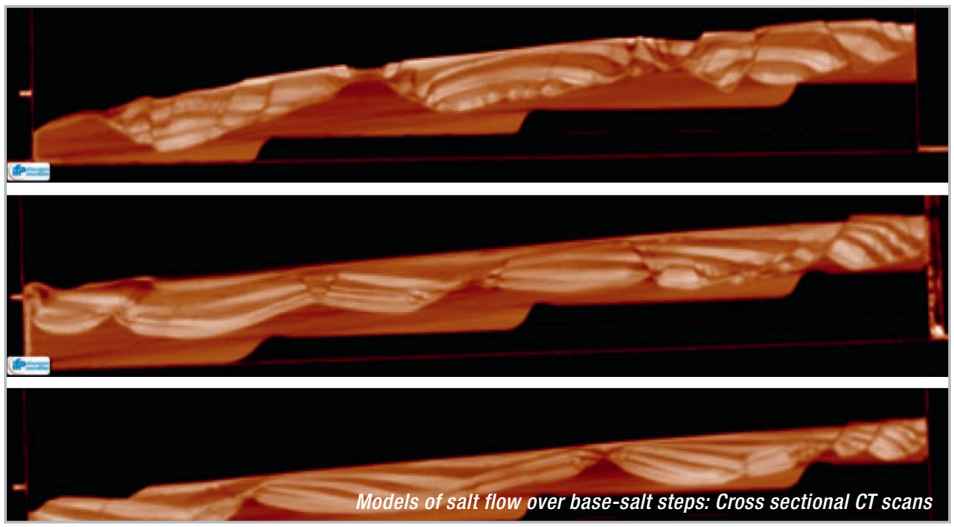
The models I ran at IFPEN were specifically designed to test the influence of salt flow over steps on the base-salt surface. Since salt behaves as a fluid, it is sensitive to the geometry of the surface that it flows across; for example, pre-existing fault scarps at the base of the salt deposit. The models allowed the silicone to flow over a series of steps and ramps at different angles. Each of these models was run for different starting conditions in order to isolate the effect of different variables and their relative importance. As it turns out, relief on the base-salt has a profound impact on the subsequent structural evolution of the



The lab setup at IFP Energies Nouvelles: Models run within a CT scanner and imaged in real time as they deform, revealing their internal structural complexity

salt and overlying sand units, by creating local stress fields (extensional or contractional) and controlling the distribution of sedimentary depocentres (where accommodation space is created and thick sediments accumulate). Many of the structures developed in the models closely resemble structures that we observe in our seismic data, providing valuable insights into their kinematic development.

One of the key findings is the importance of initial salt thickness. Models run with a thin silicone layer (i.e. thin salt unit) resulted in a significantly different structural configuration from those with a thick silicone layer (i.e. thick salt unit). The models with thin silicone showed much greater localisation of strain above the base-salt steps, indicating strong coupling between the salt deformation and the base-salt geometry. By contrast, the thick silicone resulted in more homogeneous deformation across the model, indicating a weaker influence of the base-salt steps. This could partly explain why we observe such contrasting styles of deformation in different salt basins around the world, though of course there are other variables at play.



Models of salt flow over base-salt steps: Cross sectional CT scans

'All models are wrong, but some are useful'

Of course, modelling isn't without its limitations. As the famous quote attributed to statistician George Box opines, 'All models are wrong, but some are useful'. Essentially, the aim of the model is not to be 100% correct, 100% of the time, but to reduce the complexity of the system and isolate the influence of certain parameters in order to further our understanding of geological processes. Any scientist worth their salt (pun intended) must think long and hard about the reliability of their experiments, what they show - and perhaps most importantly, what they do not show.

My future work will continue to unravel the various structural complexities of salt-influenced basins using subsurface data and analogue models. Salt basins are already areas of prolific hydrocarbon exploration, but in the future may become important reservoirs for sequestered CO2 thanks to the excellent sealing properties of salt. It is therefore important that we continue to develop our understanding of these complex natural systems.

Sian L. Evans is a PhD student at the Basins Research Group in the department of Earth Science and Engineering at Imperial College London, and was a 2019 recipient of the Geological Society's Edmund Johnson Garwood Fund.

STRENGTHENING GEOSCIENCE IN DEVELOPING NATIONS

Darren Jones and **Tim McCormick** on how the BGS is partnering with geoscience organisations across the world

In the UK, we are fortunate to have access to world leading geoscience research institutions. But many international students from low-income countries return home with a toolbox full of geological skills and knowledge, only to find themselves frustrated with a lack of investment in geoscience in their home country due either to economic or political factors. For many years, the British Geological Survey (BGS) has been working with counterpart surveys to help mitigate these impacts; most recently as part of a multi-million pound project called Partnerships for Development (P4D) funded by the UK Department for International Development (DFID).

Natural resources

The extractives industry still provides the largest demand for geoscientists across the world. Utilisation of natural resources offers an opportunity for developing nations to enhance their economic development, with demand unquestionably high; the population in sub-Saharan Africa, for example, is expected to double over the next 30 years.

Many factors, whether the passage of time, lack of necessary investment or staff retention, have led to some low-income countries losing geological knowledge and data, or failing to keep up with the latest developments and techniques in the Earth sciences. For any country to successfully exploit natural resources in an environmentally acceptable manner, a geologically skilled workforce and a detailed understanding of its own geological make-up is key. Geological data is the essential foundation on which natural resources are governed. It is paramount, then, that those government organisations responsible have the capability to acquire, manage and understand the data.

Partnerships

Throughout its history, BGS has had a global presence, collecting geological data across the world. Since 2017, we have been providing a development role in strengthening geoscience through partnerships with geological institutions across Africa and Asia; specifically in Ghana, Kenya, Sierra Leone, the Kyrgyz Republic and Tajikistan. These partnerships form part of the P4D project, which aims at leveraging skills and expertise from UK public sector institutions and supplying them to public sector counterparts in developing countries. In our case, we are working with countries which have prioritised developing the extractives sector of their economy and identified the need to build capacity and skills in acquiring and managing geological data.

The project has involved providing in-country geological training, IT/database system development, strengthening facilities like laboratories, engagement on developing natural resource policy, and supporting acquisition of new geological data to underpin strong extractive governance.

BGS also collaborates with other international aid donors and the World Bank. In Sierra Leone we have been tailoring our training to align with a recent World Bank-funded country-wide airborne magnetic survey and a hydrocarbon licencing round. We are collaborating on best practice procedures in laboratory facilities and on developing national geological and geochemical surveys. Facilitating the transfer of geological knowledge to these geoscientists supports them in developing an impartial understanding of their natural resources and promoting their development.

In the Kyrgyz Republic our activities have focused on developing a digital workflow for the delivery of key geological datasets required for mineral exploration and the assessment of landslide risk in mineral rich areas. Peer-to-peer working alongside more formal training is helping to develop ▶

BGS geologists with partners from the National Minerals Agency, Petroleum Directorate and Fourah Bay College during fieldwork training in Sierra Leone

BGS working with the National Minerals Agency in Sierra Leone providing training using the BGS Sigma digital field mapping kit

BGS and local staff examining the Regent landslide disaster of 2017, Sierra Leone

▶ a co-designed workflow that will be sustainable into the future.

Data management

Another key aspect of our work is capacity building in geo-data management. In Kenya and elsewhere, we have been working on constructing a national 'geo-data centre'; an integrated database of geoscience data and information which stores and delivers the national geoscience knowledge base. Such data centres are essential for demonstrating a country's resource potential.

In many cases, the partner organisation is starting from a low-level of capacity in digital data management, and may not have a central data repository or networked computers. In these cases, part of our work is to help the partner install the IT infrastructure required to implement the geo-data centre. In some cases, capital funding for the hardware is provided by the national government of the country where we are working, or an international donor like the World Bank, and BGS advises on procurement. As well as obvious things like servers, PCs, and software (both open source and, where necessary, commercial) BGS advises on network setup, trains local IT administrators, and implements procedures for data back-up and disaster recovery. Once any new IT infrastructure is in place, staff members at the partner organisation are asked to read and sign an Acceptable Use Policy. This outlines what constitutes acceptable and unacceptable use of the IT facilities and helps to ensure the long-term usability of the systems put in place.

There are now many available open source options for GIS and databases. The advantages of free and open source software are obvious for government departments in low-income countries, with many finding it difficult to budget for ongoing licence and update fees for proprietary software.

Training and resources

A key element of the programme, across all partner organisations, is training. BGS trains counterpart staff to make the best use of the new equipment, to increase their software skills and to interpret and use digital geological data and information. Knowledge gained by our counterparts

during formal training is reinforced through one-to-one knowledge transfer.

We also work with partner organisations to develop data resources – for example, helping to scan and catalogue geological maps and reports. This 'Documentation Centre' protects the knowledge base against loss by fire or flood (or insect: termites love eating geological reports!), and makes that knowledge more easily discoverable and therefore useful. The searchable catalogue can then be published on the web, subject to approval by partner organisations. The ability for third parties to discover reports and maps which they can request to purchase provides potential revenue for the partner organisation.

Data resources are developed following 'FAIR' data principles (Findable, Accessible, Interoperable, and Reusable; https://www.force11.org/group/fairgroup/fairprinciples). This is achieved by making standards-based human- and machine-readable metadata catalogues, and by basing databases on published schemas and vocabularies; for example, those developed by the Commission for Management and Application of Geoscience Information (CGI; http://www.cgi-iugs.org/), and BGS' own published vocabularies like the Rock Classification Scheme (https://www.bgs.ac.uk/bgsrcs/).

The importance of a geological map

In 1815, William Smith's geological map of England and Wales represented the most advanced geological data of its day. Since then, the UK has been fortunate to have had the resources to develop multiple updated iterations of Smith's map, and to store large amounts of geological data.

Transferring geological knowledge is essential, whether through traditional fieldwork, using remote sensing, lab and sampling techniques or using geoscience software. The importance of an accurate geological map cannot be underestimated. Imagine if we were still working with those original maps – it really would be impossible to get to where we are today. This is the issue faced by developing countries, and why the development of partnerships based around geological skills and data is so essential.

By geologist Darren Jones and geoscience data specialist Tim McCormick from the British Geological Survey

Certification presentation after delivery of a GIS training course with geologists from the State Committee for Industry, Energy and Subsoil Use (SCIESU) in the Kyrgyz Republic

Computer training in the Kenyan Directorate of Geological Surveys (DGS) Geo Data Centre

ACKNOWLEDGEMENTS

Thanks go to the partner country organisations mentioned above and the UK Department for International Development for supporting this project

FURTHER READING

Goodenough, K.M.; Jones, D.; Ford, J. 2018 *Geological mapping of Sierra Leone: baseline assessment* and next steps. Nottingham, UK, British Geological Survey, 19pp. (OR/18/004). http://nora.nerc.ac.uk/id/eprint/519869

Partnerships for Development (DFID). 2020. https://devtracker.dfid.gov.uk/projects/GB-1-205191

BGS discussing lab procedures with National Minerals Agency staff in Sierra Leone

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Sulfur in the Earth system:

From microbes to global cycles through Earth history

16-17 November 2020

The Geological Society, Burlington House, London

The cycling of sulfur has been important in controlling the chemistry of Earth's surface environments for billions of years at scales from the microscopic to the whole globe. It plays fundamental roles in many microbial metabolisms, in the transition to the oxygenated atmosphere and oceans of the Phanerozoic, and is a key volatile in volcanic systems. Studies of various aspects of the sulfur cycle have been accelerating in recent years but are spread across a range of scientific communities.

During this meeting, The Earth System Science Group will aim to bring these diverse studies together to foster a holistic understanding of the role of sulfur in the Earth system. We welcome the studies of microbiological and experimental systems, the sulfur chemistry of terrestrial environments and the atmosphere, the marine sulfur cycle including hydrothermal and vent systems, sulfur in the deep Earth and volcanic systems, and records and models of sulfur cycling across Earth history.

Call for Abstracts

We invite oral and poster abstract submissions for the meeting, and these should be sent in a Word document to conference@geolsoc.org.uk by Friday 11th September 2020. Abstracts should be approximately 250-350 words and include a title and acknowledgement of authors and their affiliations.

Main Convenor:

Dr. Robert Newton (University of Leeds)

Convenors:

Dr. Andrea Burke (St. Andrews) Geochemistry SG

Prof. Graham Shields (UCL) Chair, Earth System Science SG

Dr. Sasha Turchyn (Cambridge) Chair, Marine Studies SG

Keynote Speakers:

Tamsin Mather (University of Oxford)

Ben Mills (University of Leeds)

Itay Halevy (Weizmann Institute of Science)

Emma Liu (University College London)

Further information:

For further information about the conference please contact:

Conference Office, The Geological Society, Burlington House, Piccadilly, London W1J 0BG

T: 020 7434 9944 **E:** conference@geolsoc.org.uk

Web: www.geolsoc.org.uk/events

Follow this event on Twitter: #gslsulfur2020

Due to the ongoing situation with Covid-19 and acting on advice from the UK Government, the Society's offices in London and Bath are closed at time of writing. Unfortunately, this is impacting some of our upcoming events – we are rescheduling and adapting to virtual events where possible.

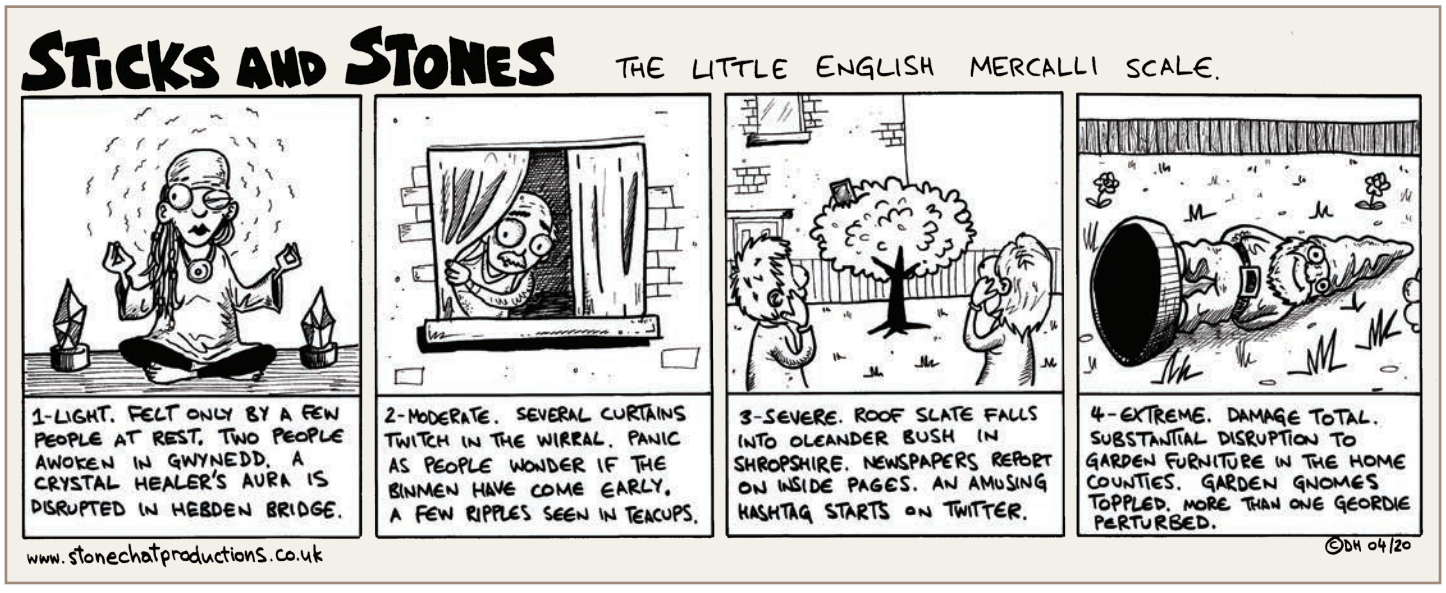
Please visit www.geolsoc.org.uk/events for the latest updates. If you have any questions about upcoming events, please contact conference@geolsoc.org.uk.

VIRTUAL EVENTS

MEETING	DATE	VENUE AND DETAILS
June Public Lecture: Strategies in times of crisis – lessons from past marine ecosystems	23 June	Lecture **Venue:** Taking place remotely **W:** further details to be announced at www.geolsoc.org.uk/strategiesintimes
Mineral resources estimation: recent advances and current best practice	19 October	Conference **Venue:** Taking place remotely **W:** www.geolsoc.org.uk/10-gsl-mineral-resource-estimation-2020

RESCHEDULED EVENTS

MEETING	DATE	VENUE AND DETAILS
Marine Reptile Conference 2020	29 Sept – 1 Oct	Conference **Venue:** The Etches Collection, Kimmeridge, Dorset **W:** www.geolsoc.org.uk/09-rescheduled-marine-reptile-conference-2020
Plastics in the Environment	15 March 2021	Conference **Venue:** Burlington House, London **W:** www.geolsoc.org.uk/plastics2021
Core Values: the role of core in 21st century reservoir characterisation	5-7 May 2021	Conference **Venue:** Burlington House, London **W:** www.geolsoc.org.uk/05-rescheduled-pg-core-values-2021
William Smith Meeting – Mapping of our world and others	19-21 October 2021	Conference **Venue:** Burlington House, London **W:** www.geolsoc.org.uk/wsmith21



BOOK REVIEWS

Folding and Fracturing of Rocks: 50 Years of Research since the Seminal Textbook of J. G. Ramsay

The study of rock structure sometimes appears to be in danger of being confounded by the use of poorly defined terms that may be both restricting to thought and confusing to the reader. In the past the study of rock deformation has often avoided the precision of real mathematical formulation to escape into a specialized type of obscure symbolic jargon. (Ramsay, 1967)

When reflecting upon the original lectures and the book, it is obvious that the person who wrote those words believed in using clear, relatively plain and unambiguous language to describe the subject matter. Indeed, on rereading my own copy of the original book, I am struck by the utter practical clarity of expression, which has stood the test of time.

Ramsay also espoused three further tenets in his work as a lecturer; getting the fundamentals right through the use of mathematical reasoning, use of practical modelling and providing field examples to assess theory against hard reality.

This Special Publication is a homage to the original book and its author; indeed the sequence of the papers follow from that work. Techniques of data collection, analysis and the graphics of presentation have all changed, but this body of literature is clearly from the same school of thought.

Disciples and followers have gone forth and developed and applied the methods over 50 years, and so this book is a report back on what some of those people have achieved with those original concepts.

However, have these disciples upheld the primary tenet, that of clear and plain communication style? Indeed, is it even appropriate to ask that question? Well, unless the publication is only intended for a small select group, then really we have to use the question as a test. The answer, in my mind at least, comes in the form of the paper Where have all the buckles gone? (Butler et al), which concludes that 'they are all still there' - although in the process of fleshing out detail, simplicity of expression and concept have been subjected to progressive creep, in my words.

This is a very impressive update on how folding and fracturing can be studied, with some very useful and well-illustrated case histories; although some researchers here are treading a fine line between describing technical innovation and some obfuscation. So don't forget Ramsay's words - they are still very relevant today.

Reviewed by ***Arthur Tingley***

FOLDING AND FRACTURING OF ROCKS: 50 YEARS OF RESEARCH SINCE THE SEMINAL TEXTBOOK OF J. G. RAMSAY
by C. E. Bond and H. D. Lebit (eds) 2020. Geological Society Special Publication 478, 352pp, hbk
W: www.geolsoc.org.uk/SP487

Exploring Geoscience Across the Globe

Chris King, Emeritus Professor of Earth Science Education, Keele University, has written this excellent Open Access book *Exploring Geoscience Across the Globe*. It has been prepared to support the teaching of the International Geoscience Syllabus (IGS) (itself reproduced in an Appendix).

Readers of *Geoscientist* know that geoscience is the scientific study of our planet, or nowadays the whole solar system. Geoscientists therefore investigate the Earth from atomic to global scales using elements of geology, biology, chemistry, physics, maths, geography, HSE, economics and engineering. We cover sub-topics - amongst others, geochemistry, geophysics, palaeontology, hydrogeology and engineering geology to study meteorology, oceanography, soil science, aspects of the solar system, mineral exploitation, environmental science and much more. This huge range of activities covering natural phenomena, important professional wealth-earning industries and environmental concerns is introduced in this book.

King moves in simple jargon-free language through the geoscience background theory to application. He discusses the geosphere, atmosphere, hydrosphere and biosphere, and indicates many beneficial applications but also some of the negatives, such as pollution, including industrial mining-waste poisoning, oil pollution from tankers, plastic debris going into food chains and climate change. The topics are covered in some 7 chapters, starting with the basics of the water, rock and carbon cycles and energy sources, including renewables and geothermal, and moving onto the systems of the Earth, explaining seasons and eclipses and geological time scales. The formation of metamorphic, igneous and sedimentary rocks, the effects of tectonic plates and the fascination of fossils follow, then details of the Earth's internal structure, the hydrosphere, including oceans, and the layers of the atmosphere. Next come raw materials within Earth, the plusses and minuses of mineral exploration and exploitation such as mining and energy from fossil fuels. Natural hazards of earthquakes, volcanoes, tsunamis and landslides lead on to the problems created by humans, particularly some background to climate change.

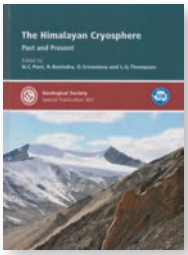
King presents all apolitically - just the facts. His text is beautifully illustrated with many examples presented clearly in tables, photographs and 'interest boxes'. A separate 'Activity Supplement' provides teaching activities and questions to test knowledge and understanding. This resource for supporting educators across the world in teaching the IGS is superb.

Open Access books permit a 'free' read via http://www.igeoscied.org/teaching-resources/geoscience-text-books/ then 'Exploring-Geoscience-across-the-globe'. So if you are a new Earth science/geology/geoscience student, an environmentalist (or protester), or are looking for a good grounding of sound knowledge on 'green issues' you should download and digest this book. I shall be recommending this excellent introduction to my students, and, naturally, any 'extinction rebellionist' needing proper unbiased background.

Reviewed by ***Richard Dawe***

EXPLORING GEOSCIENCE ACROSS THE GLOBE
by Chris King, 2019. Published by International Geoscience Education Organisation, IGEO. Available as pdf. 238pp. ISBN: 978-1-9996264-0-2
Cost: free via internet, http://www.igeoscied.org/teaching-resources/geoscience-text-books/ then go to 'Exploring-Geoscience-across-the-globe'.

Himalayan Tectonics: A Modern Synthesis



This is a quite outstanding superb summary of present knowledge, in 21 accounts, by ~50 leading experts on the tectonics, structure, stratigraphy, metamorphism, magmatism and geophysics of the Indian-Asian collision zone which produced the highest mountains in the world. The coloured maps and cross-sections make the complex geology - produced by the initial impact with Asia of northward moving oceanic crust giving obducted (largely eroded) and subducted arcs and the later collision of the northern Indian continent under Asia - easy to follow. Initiation was ~120 Ma with the main continental collision from ~55 Ma continuing today.

After a most helpful introduction, the text is grouped under Timings and stratigraphy; NW Himalaya; Nepal Himalaya; Geophysics; Karakoram-Pamir-Tibet; and the Monsoon system (mountain influence). The geophysics is earthquake studies and seismically deduced thrust and back thrust packets that make a crust up to 80 km thick. The relatively simple E-W 1500 km of the main Himalayan range, with four main thrusts or detachments and a northern batholith, occurs between two complex syntaxis regions at each end. Here the range sharply bends southwards and post Miocene metamorphism continues variably overprinting the main 46 Ma Eocene to Miocene metamorphism. At the NW syntaxis the Kohistan arc separates the Indian and Asian plates and was first thrust southwards onto the Indian plate and then northwards under Asia.

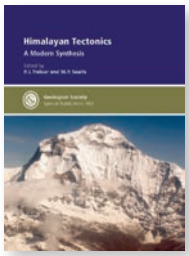
Major problems, often identified, remain, such as the South Tibetan detachment with anticlockwise P-T-time metamorphism in its ductile shear zone, the opposite of the re-assuring general Himalayan Cenozoic clockwise picture in a pile of variably folded thrust and back thrust packets, many moved hundreds of km. Some packets reveal gneiss domes and metamorphic core complexes that have moved horizontally before being propelled upwards; others unexpectedly still preserve Ordovician metamorphism or 1860 Ma ages; one of the last is without Cenozoic imprint despite being <1km below the Main Mantle Thrust. Cretaceous lawsonite blueschists, eclogites, some of Eocene age with coesite and some with Oligocene-Miocene granulite facies overprinting, and earlier microdiamond-bearing rocks occur. Some Ultra-High-Pressure rocks had astonishingly high exhumation rates (45-90 mm per year) which were sometimes increased by major rivers constantly removing floods of clastic sediments thus reducing overburden pressures.

Overall this is a quite outstanding book of an extremely complicated region that is unreservedly recommended, giving a glimmer of what happened in the top levels of older orogenies, now lost forever by erosion.

Reviewed by ***Bernard Elgey Leake***

HIMALAYAN TECTONICS: A MODERN SYNTHESIS
by Peter J. Treloar & Mike P. Searle (eds), 2019. Published by The Geological Society 669pp (hbk) Special Publication 483, ISBN: 9781786204059
List Price: £ 160.00. W: https://doi.org/10.1144/SP483.2

The Himalayan Cryosphere: Past and Present



This volume represents a follow up to the XII International Symposium on Antarctic Earth Science, organised by the Scientific Committee on Antarctic Research (SCAR). Its aim is to address the existing highly variable base-level data on the Himalayan cryosphere by providing new data from locations distributed over the Himalaya region and Tibet, providing some insight into the late Quaternary cryosphere over a wide area. The Himalayan cryosphere contains the third-largest expanse of ice cover in the world and has been described as the 'third pole', with the Himalayas the source of ten major rivers that support one of the most densely populated regions in the world. Understanding the impact of the current warming trend on glacier dynamics and recession rates, and in turn the hydrological budget, is crucial to developing appropriate sustainable strategies which support and protect the many who are likely to be impacted.

The volume brings together twelve papers, preceded by an introductory paper by the Editors which usefully sets the scene. It is split into three main sections addressing the 'Past', the 'Present' and 'Sustainability', containing four, six and two papers respectively. The papers in the first section,'Past', cover ice-cored palaeoclimate studies, formation and breaching of two palaeolakes, depth profiling and recessional history of glaciers and geomorphic evolution of a glacier-fed valley in the context of Late Quaternary climate change, monsoon dynamics and glacial fluctuations.

The second section on the 'Present' contains papers on the precipitation perspective of the hydrosphere-cryosphere interaction, development of an algorithm for estimation of snow-cover fraction, mass-balance modelling of a glacier, annual cycle of temperature and snowmelt runoff, temporal variations in snow albedo and wintertime surface energy balance of high-altitude seasonal snow surface.

The third and final section of the volume on 'Sustainability' contains only two, but nevertheless important papers, covering sustainable development and geohazard mitigations through an understanding of Earth surface processes and landscape evolution, and the hydrological budget in the context of sustainability of water resources in high mountain Asia.

Overall the volume is well produced and edited, suitably illustrated and achieves its aims. It should appeal to a wide geological/geomorphological audience, particularly those with an interest in climate change impact over higher altitudes and the implications for glacier dynamics and recession rates. Hopefully this volume will be a catalyst for inspiring further research on the subject, particularly on the sustainability aspects covered.

Reviewed by ***Colin J. Serridge***

The Himalayan Cryosphere: Past and Present
by Pant, N.C., Ravindra, R., Srivastava, D. and Thompson, L.G. (editors). Geological Society of London Special Publication No 462. 2018. Geological Society of London. ISBN 978-1-78620-324-3. Hbk. 216 pp. ISSN 0305-8719. **List Price : £90.00, www.geolsoc.org.uk/SP462httorg/10.1144/SP483.2**

READERS' LETTERS

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

OLD HABITS DIE HARD

Dear Editor, During the current lockdown, it is natural for parents to turn to what they might expect to be an obvious trustworthy online source, BBC Bitesize – particularly when advertised daily on the TV and supported by celebrity presenters. But as I trawled through the online provision being presented to GCSE geography and chemistry students, I was disheartened to see the quality of some of the geological information on offer.

With others, I have previously railed at the dubious quality of some textbooks and websites on geological content, but to find the BBC also perpetuating misconceptions on plate tectonics and Earth structure in their online provision was disappointing. Now I see the same errors reproduced by the Oak National Academy online initiative and championed by the Secretary of State for Education, Gavin Williamson. Whilst better informed teachers would no doubt be able to redress the errors, what chance have the poor parents saddled with home-schooling and expecting an authoritative resource?

The Geological Society's own annual GEA programme (Geoscience Education Academy) was set up specifically to update science and geography teachers, without a geological background, tasked with teaching these concepts within their curricula. However, it seems that old habits die hard.

It doesn't need to be like this, if only authors fact checked their outputs with reputable authorities, like the Geological Society. Our current models of the Earth, based on evidence, are just as easy to teach, even to younger students - as many STEM ambassadors and other presenters know.

I salute all parents and teachers currently coping to provide meaningful lessons for home-school students and hope the references provided (see pages 24-25, *Editor*) will be useful and help combat misconceptions perpetrated elsewhere.

PETE LOADER (FGS)

A PRECAUTIONARY APPROACH – FOLLOW-UP


READERS' LETTERS

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

UNREASONABLE DOUBT

Dear Editor, I agree with everything in Hugh Richard's recent Soapbox article (Richards, H., Face facts on fossil fuels. *Geoscientist* 29 (11), 9, 2019 https://doi.org/doi: 10.1144/geosci2019-059) apart from the final sentence: *'... if humanity is going to fail to avert 'Hothouse Earth', let it be primarily a failure of politics, not enabled in part by a failure of science communication.'*

As many climate science experts, such as James Hansen and Michael Mann, have pointed out, humanity's failure to take effective action to minimise the effects of burning fossil fuels - predicted over 125 years ago, well understood for over 50 years and identified 30 years ago - is primarily due to a multi-decadal, industry-funded campaign to discredit scientists, perpetuate unreasonable doubt and prevent governments from declaring that fossil fuels must be left in the ground. Therefore, I am sure that he will (have) upset the recalcitrant contrarians within the Society who are (or were) predominantly employed in the fossil fuel industry.

MARTIN LACK (FGS, CGEOL)

Face facts on fossil fuels

SOAPBOX CALLING!

A PRECAUTIONARY APPROACH

Dear Editor, Hugh Richards makes some interesting points in his Soapbox article in the December issue. He asks some questions that scientists might be expected to answer. I suspect that the answer to most of them is that we don't really know. What we do know is that humanity is extracting geological reduced carbon and transforming it into atmospheric oxidised carbon at an unprecedented rate, that the atmospheric concentration of carbon dioxide is increasing, ocean pH is decreasing, and there is evidence of climate warming.

Since there is a suggestion that the consequences will be really bad, such that we and much other life may not survive, a precautionary approach seems to be well justified. I would therefore suggest that the 'politics' is more important than detailed science, but I agree that science communication is critically important.

Communication of bad news to the public is really difficult. I think that politicians need to listen to the difficult science, and then persuade us public that using hydrocarbons is unacceptable, probably through a structured taxation process. Government also has a role to play in reducing the carbon content of current lifestyles, and in improving the insulation standards of UK housing stock. It's not just a matter of demonstrating and school strikes, but real change in lifestyle that we all have to do together. No more long-haul holidays!

Attempts to control hydrocarbons by leaving them in the ground would be difficult and would probably only encourage criminal dealing. Monitoring would be difficult. What would be easier to monitor is distribution - tankers and big pipelines are really visible. However, preventing distribution could be very unfair - some countries do not have much in the way of native energy sources.

A final thought: if fossil fuel use is so bad for the planet (I think that it is), is it ethical for geologists to be involved in exploration and production of said fossil fuels?

JOHN HEATHCOTE (FGS)

WWW.GEOLSOC.ORG.UK/GEOSCIENTIST | FEBRUARY 2020 | 25

Dear Editor, In reply to various letters, I will admit to making a comment (Letters, *Geoscientist* **30 (1)**, February 2020) that was intended to provoke thought, which I hoped would be read that way rather than as condemnation of all those who work in the fossil fuel industries. If I caused offence, I am sorry - that was not my intent. I admit also that I benefit from the use of hydrocarbons, both as road fuel and as a raw material for manufactured goods like the computer I am using. I do my best to minimise such use, but there is not always a practicable alternative.

But there is also no denying that our planet cannot cope with all of us using Earth resources at the rate now used in 'the west'. As geologists we probably have a better appreciation of the larger scale and long time implications of mankind's current behaviour. We certainly have a role in finding a solution, but in my view that will not be exploiting resources to meet unfettered demand.

I'm comfortable that I've had a career in geology. It was only happenstance that it ended up in contaminated land management, via groundwater resource management. The ability to join aspects of the 'pure' sciences together and apply them to the real world is very valuable. I would certainly encourage others to join us. There is plenty of work for geologists to do and not all of it is in resource exploitation.

JOHN HEATHCOTE (FGS)

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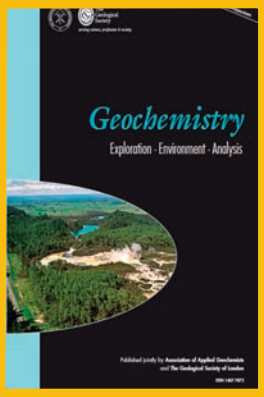

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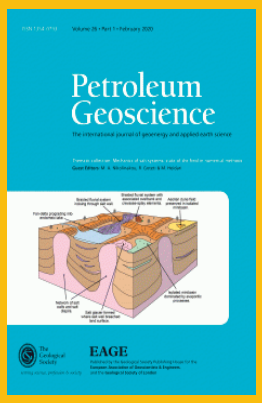

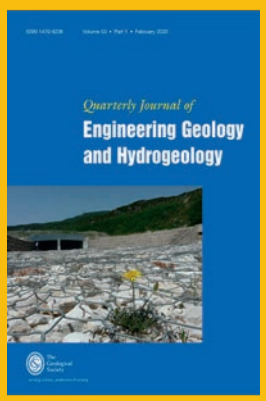

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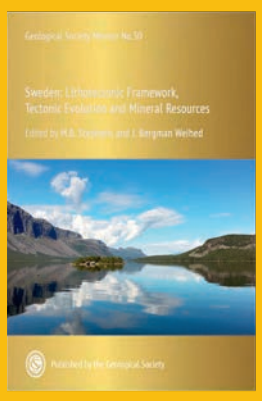

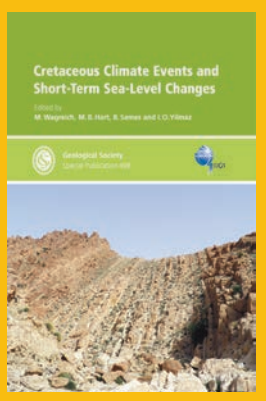

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Geology, home-schooling and toilet rolls!

Pete Loader has advice and resources for those currently home-schooling

For any educator, the current lockdown provides a valuable opportunity to support teachers and parents alike in their task of home-schooling the nation's children. This is undoubtedly providing a challenge, particularly for parents without the knowledge, experience or suitable resources, and given the dubious quality of some of the offerings (see Letters, p 22.)

Misconceptions

Of particular concern is confusion resulting from the way geologists describe the chemical layering of the Earth and its mechanical structure. This has led to misconceptions, perpetuated by some websites and many geography textbooks, that can be paraphrased thus:

'the Earth's mantle is composed of molten, liquid rock called magma upon which the Earth's crust 'floats'; with the latter broken into pieces called plates, that are moved by convection currents within the mantle.'

This, despite the valiant attempts of the geological community, exam boards and the Geographical Association, to dispel such myths over many years. The 'crustal' part of the plate as portrayed is only the outer part of what we now know to be a 'lithospheric' plate; a mechanical, rather than a chemical description of the cold (<1300 °C), strong, outer Earth layer comprising both crust and the upper-most part of the upper mantle. (See Fig 1).

Similarly, the mantle can't be molten liquid (except in very localised situations) as it transmits earthquake waves (S-waves) which are not transmitted through non-rigid materials. Whilst the detail mechanism of plate movement is still much debated, recent evidence suggests that:

- there is little or no evidence that convection currents in the mantle move plates;
- slab pull is the main plate-driving mechanism, which is part of the convection system since sinking cold, dense lithosphere itself can drive mantle convection patterns and influence mantle flow.
- ridge push can have an effect where slab pull is not the main plate driver.

Of course, this is a simplification in itself, but it is a more appropriate model with which to teach students that better reflects current understanding.

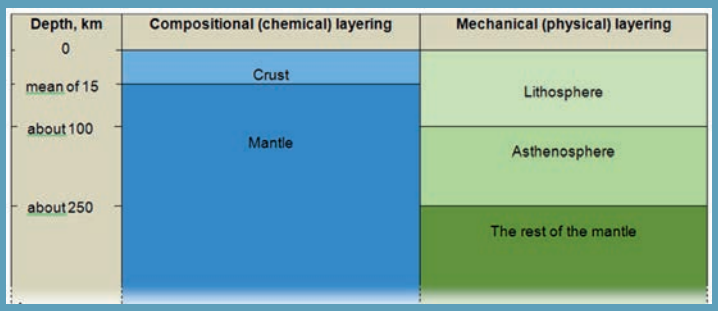


Fig 1:'What do the top and bottom of a tectonic plate look like?' (Earth Learning Idea)

Integrity

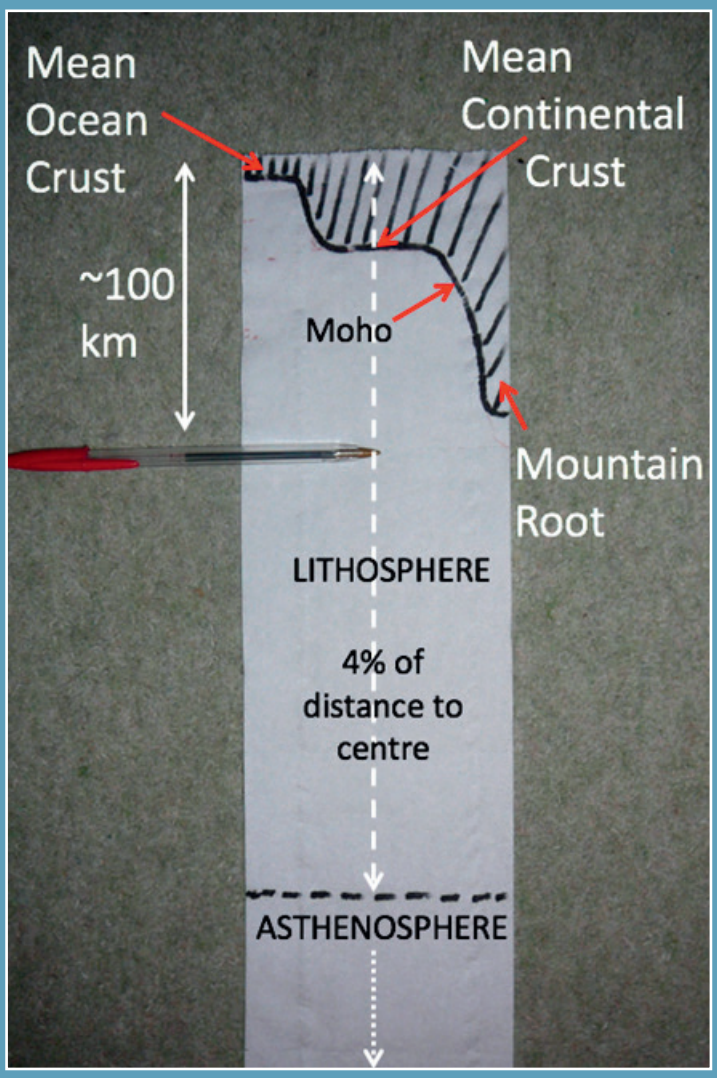
When I tweeted recently about errors in the BBC Bitesize provision, some asked whether this really matters, in the bigger scheme of things. To which I would argue yes, if we value the quality of our children's education and the integrity of our subject and curricula. Not only are misconceptions something students would need to relearn further up the education ladder but it also avoids a situation where a student, studying both geography and geology at GCSE, is potentially faced with different answers to the same questions and the worry of what is going to be accepted in exams.

Some responded to my tweet by asking to be pointed towards accurate and engaging resources that could be used to support home learning, and indeed in future school lessons. I outline here just a few of the options.

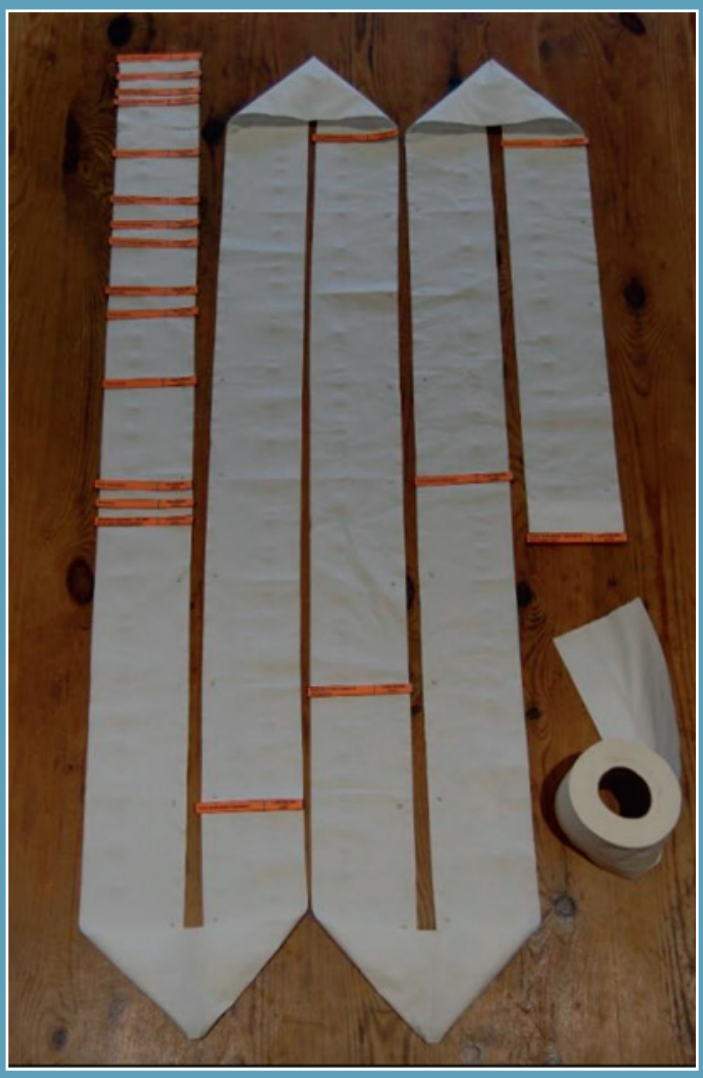
Geological Society resources

A wealth of information and activities for students of all ages can be found on the Geological Society's website (**https://www.geolsoc.org.uk/education**). They range from fact sheets, activities and presentations to Fun Kids radio programmes, with much else besides.

In particular, the highly acclaimed 'Plate Tectonic' website (**https://www.geolsoc.org.uk/Plate-Tectonics**) for Key Stage 3 students and upwards was written in 2012 specifically to dispel the outdated models of the Earth we see perpetuated. This was supplemented by the 'Plate Tectonic



Journey to the centre of the Earth – on a toilet roll (Earth Learning Idea) Image courtesy of Pete Loader



Toilet roll of time' (Earth Learning Idea) Image courtesy of Chris King

Passport' activities for Key Stage 2 and lower Key Stage 3 students and later by 'Plate Tectonic stories', in celebration of 50 years of plate tectonics.

Earth Learning Idea

The merits of the Earth Learning Idea website (**www.earthlearningidea.com**), which produces Earth related teaching topics, have been outlined previously in Geoscientist (2009 – February and July) and since then have continued from strength to strength. New Earth Learning Ideas continue to be published every two weeks and are ideal as a practical resource for home schooling activities, requiring only the basic use of laboratory (kitchen) equipment, if at all.

Many of the activities have been translated into 12 languages, and recently teaching videos and workshops have been introduced. All activities are free to download, informative and provide a realistic explanation of some of the complexities of Earth science whilst being very much aware of the misconceptions that can be engendered with simplicity. And they are fun!

With regard to the inconsistencies in understanding of Earth structure and plate tectonics, the following are most useful:

- "What drives the plates" **https://www.earthlearningidea.com/PDF/217_Slab_pull.pdf**
- "All models are wrong … Plate driving mechanisms" **https://www.earthlearningidea.com/PDF/326_Plate_driving_mechanisms.pdf**
- "What do the top and bottom of a plate look like?" **https://www.earthlearningidea.com/PDF/334_Top_bottom_plates.pdf**

One of the more popular Earth Learning Ideas uses a toilet roll to make a scale model of the structure of the Earth and its layers (**https://www.earthlearningidea.com/PDF/196_Journey_centre_E.pdf**), whilst the Toilet Roll of Time (**https://www.earthlearningidea.com/PDF/234_Toilet_roll_of_time.pdf**) helps students understand the duration of geological time and the timing of key events.

Now I wonder if this has anything to do with the recent shortage?

Pete Loader is Principle Examiner for A Level Geology and Chair of The Geological Society's Education Committee

DISTANT THUNDER

Rhyme Time

Geologist and science writer Nina Morgan explores the power of poetry

From Tennyson to Ted Hughes with Auden and many others in between, poets looking to describe the natural world often turn to geology. Geologists, in turn, are often attracted to poetry, not only for its beauty, but for the way poetry can crystallise concepts and stimulate the brain. As geologist and part-time performance poet Mike Stephenson has found, poetry can also serve as great way of introducing geology and science to the public at large (see *Geoscientist* December 2018, pp 10 – 13, and *Geoscientist* May 2020, pp 22-23). In short, poetry can have the power to summarise geological concepts in a witty and memorable fashion.

Fun with fundamentals

For example, Gordon Judge, an amateur geologist and treasurer of the Horsham Geological Field Club, gets down to the fundamentals of fossilisation with his poem, The Fossil Record.

As Judge explains: "Books on geology keep referring to 'the fossil record', but never define what it is." Well, here's his answer:

They say the fossil record
Can date a rocky layer
(That's odd, because I've yet to see
A fossil record player...)

"I dunno what you're sayin',
"A nearby fossil said,
"You youngsters think yer know it all
Get this inside yer 'head:

"Yer gets a fossil *record*
If yer does a fossil *crime*
(I can't remember what I done,
But I done a lotta time ...)"

Palaeopoetry

Judge's witty take on geology and stratigraphy follows in the footsteps of earlier science-popularising poets. The newspaper columnist, Bert Leston Taylor [1866 – 1921] was an earlier exponent of this genre. His classic poem, The Dinosaur, first published in the *Chicago Tribune* on 26 February 1903, was written in reaction to a news item published the previous day. The accompanying photograph to the news article showed Professor Oliver C. Farrington [1864 – 1933] of the Chicago Field Museum and University of Chicago, 'chiselling on the huge bones of the great dinosaur that was discovered in the Coma beds of Wyoming in 1901'. And the caption revealed that "...the dinosaur was seventy feet long and it has been found that he had not only a brain in his head but another well down his back, sixty feet from the primary seat of his intelligence. The second brain controlled the nerve power that worked the second section of his body."

Behold the mighty Dinosaur,
Famous in prehistoric lore,
Not only for his weight and strength
But for his intellectual
length.
You will observe by these
remains
The creature had two sets of
brains –
One in his head (the usual place),
The other at his spinal base.
Thus he could reason *a priori*
As well as *a posteriori*.
No problem bothered him a bit;
He made both head and tail of it.
So wise he was, so wise and solemn
Each thought filled just a spinal
column.
If one brain found the pressure strong
It passed a few ideas along;
If something slipped his forward mind
'Twas rescued by the one behind;
And if in error he was caught
He had a saving afterthought.
As he thought twice before he spoke
He had no judgments to revoke;
For he could think, without
congestion,
Upon both sides of every question
Oh, gaze upon this model beast,
Defunct ten million years at least.

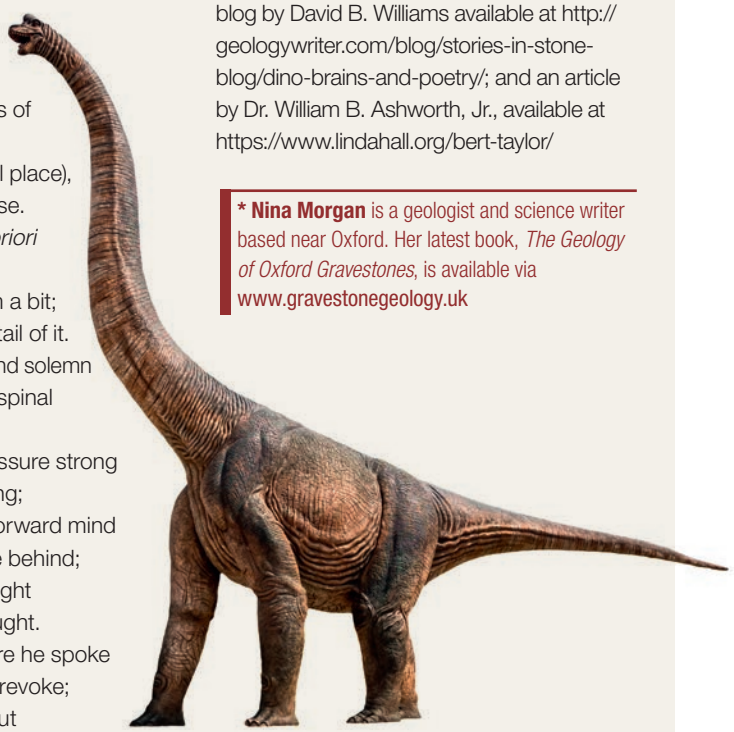
Brain drain

We now know that the dinosaur that inspired this poem was a *Brachiosuarus* and that the bone Farrington was working on was a vertebra. Alas, we also know that no dinosaurs had two brains. The confusion may have come about because of an enlarged space in the *Brachiosaurus's* vertebrae which was mistakenly interpreted as a location for a second brain.

Speaking for myself, I find this rather disappointing. An ability to reason both *a priori* AND *a posteriori* would come in very handy!

End notes: I thank Philip Powell of the Oxford University Museum of Natural History for drawing the poems mentioned here to my attention, and Gordon Judge for permission to reproduce his poem The Fossil Record. For more of Judge's poetry see: www.geoverse.co.uk; Other sources include a blog by David B. Williams available at http://geologywriter.com/blog/stories-in-stone-blog/dino-brains-and-poetry/; and an article by Dr. William B. Ashworth, Jr., available at https://www.lindahall.org/bert-taylor/

* **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



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

The Barrow Award 2020

The first Barrow Award of the Metamorphic Studies Group (MSG) is awarded to Dr Clare Warren of the Open University. In an announcement, the MSG said:

'Clare is an outstanding scientist who has demonstrated consistent excellence in and commitment to not only doing first-rate research in metamorphic geology, but in inspiring others to do the same through personal example and constructive engagement in her own community and beyond. She is someone who creates opportunities for herself, her students and the geological community at large.'

A Senior Lecturer at The Open University, UK, Dr Warren completed her undergraduate and PhD studies at the University of Oxford, and was subsequently a Killam Fellow at Dalhousie University, Canada. Her contributions to metamorphic petrology range from mineral scale processes (Ar diffusion) to large-scale tectonics (exhumation of UHP rocks or evolution of the Himalayas).

'Clare's outstanding scientific record in metamorphic geology, her excellent efforts in supervising students of metamorphic processes and her highly commendable activities in support of the metamorphic community make her a well-deserved awardee of the Barrow Award.'

The Barrow Award is named after George

Barrow (1853-1932), geologist with the Geological Survey of Great Britain and the first to assign index minerals to zones of progressive metamorphism, Barrow Zones. It will be given annually to a scientist who has made an outstanding contribution to metamorphic studies. The MSG are now accepting nominations for the 2021 Award, which will be given in the year of the Group's 40th anniversary. The deadline for nominations is 31 October 2020 – for more information, visit https://metamorphicstudiesgroup.wordpress.com/

The Society notes with sadness the passing of:

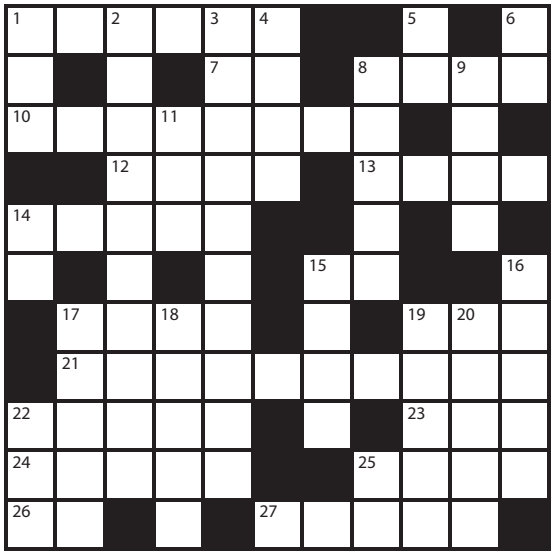
Brooks, John*
Cambray, Frank W*
Chambers, Henry*
Donovan, Desmond*
Glennie, Ken
Greenleaves, Keith*
Hunt, Albin Digby*
Holland, Charles
James, Ella*
King, Cuchlaine*
Morey, Colin Robert*
Pascall, Carolyn*
Potter, John F
Reading, Harold
Rhodes, Frank*
Snelling, Norman John
Walton, Derek*
Williamson, Iain

In the interests of recording its Fellows' work for posterity, the Society publishes obituaries online, and in Geoscientist. Bold, recent additions to the list; * Fellows for whom no obituarist has been commissioned; § biographical material lodged with the Society.

If you would like to contribute an obituary, please email sarah.day@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.

Crossword



Across

1 See 8
7/5D Cyclic form of tectonics (2-2)
8/6D/1/9D Hill on the Tour de Yorkshire named for its karstic features (4,2,10)
10 Female parts of flowers (8)
12 ____point: sharp change of slope in a river (4)
13 Crushed nuts for example (4)
14 Prehensile claw of an arthropod (5)
15 International vehicle registration of Belarus (2)
17 A woolly mass of particles (4)
19/14D Tree in the genus Betula (5)
21 Rock grease? (10)
22 E.g. Verdi, Cristo, or Carlo (5)
23 Palm strip used for writing (3)
24 Crumbly limestone found in Teesdale (5)
25 Material rich in cellulose and lignin (4)
26 Internet code for Greece (2)
27 Hovercraft used to cut grass (5)

Down

1/4/8 According to Ives, a mountain with soda water fountains (3,4,5)
2 Act of boring or digging through the ground (10)
3 Something immediately appealing (3-7)
4 See 1
5 See 7 Across
6 See 8 Across
8 See 1
9 See 8 Across
11 Texas tea (3)
14 See 19 Across
15 Piece of volcanic ejecta (4)
16 ----- crust. Type of 15d (5)
17 4d -----. Used to make 16d? (5)
18 11d made from roses (5)
19 Loch on which Ullapool stands (5)
20 House built of snow and ice (5)
22 Substance rich in umami (3)
25 Wyoming (2)

By Bindweed

Solutions May| Across: **1** thorianite **7** ultramarine **11** Marantaceae **12** long-sleeved **13** neurotomies **18** geologists **Down**: **1** tourmaline **2/14** obtuse **3/4** inanga **5** tri **6** legendists **8** realgar **9** matelot **10** rock elm **15/16** oolong **17** ifs

Getting Involved

Nick Rogers reflects on his two years as President

Being President of the Geological Society of London has been both a pleasure and a privilege and one that I did not expect to happen - until I realised that anything is possible if you throw your hat in the ring!

One of the joys has been getting to know colleagues from different geological backgrounds and attending events that I would not have the opportunity to do otherwise. I never cease to be amazed by the range of knowledge and skills acquired by professional geologists and the different spheres in which we operate. I have greatly enjoyed working with the staff and Council, all of whom I have found supportive to me personally, for which I am extremely grateful.

There have been many high points during my two years at the helm, including numerous public lectures, both my own and others, and President's Day. One that is firmly imprinted in my memory is the book launch for William Smith's Fossils, when the guest of honour was David Attenborough, arguably our most illustrious Honorary Fellow. It was such a pleasure showing him around the Society's premises -he is still very much a geologist at heart.

Various subjects have been matters of ongoing discussion throughout the past two years. Most significant has been the lease and it is one of my regrets that we have yet to resolve this. Another is climate change. My term of office started with an open letter from a small number of Fellows arguing against anthropogenic causes. Meanwhile, at least two Fellows have resigned because of the Society's close association with the hydrocarbon industry, while the Petroleum Group dinner at the Natural History Museum was picketed by Extinction Rebellion. The protest was all very good-humoured - if a little noisy!

Such incidents illustrate how the public perception of the petroleum industry, and hence geology, is changing. Once the saviour of the national economy through the discovery of North Sea oil, petroleum is now cast in the role of villain as one of the major causes of global climate change. Of course, such arguments are simplistic, but if we are to maintain public credibility, we need to change the story we tell about geology and geologists. Adopting a position of climate scepticism does not help in developing that new narrative which the Society, as the authoritative and independent voice of geology, is well placed to undertake.

One of the Society's great strengths is that it is a place where academia and industry meet and interact, with benefits to both sectors. So the decline in academic Fellowship came as a surprise and is a problem that we need to address with some urgency. Without a solid academic membership the Society risks losing an important part of its purpose and identity. Moreover, if we are to develop the new narrative, we need contributions from geoscientists of all backgrounds. Only then will we be able to send out a clear message to attract young people into our exciting science, for it is they who will enable geology to continue for the benefit of future generations.

As to advice to my successor, or any future president, make sure you set things in motion while President-designate. I know that Mike Daly has certainly hit the ground running and I look forward to developments under his stewardship. For personal reasons, I didn't manage to do this and so one of the projects I really wanted to get underway, a review of the Society's Degree Accreditation scheme, was delayed significantly and is now delayed further by corona virus. That year as President-designate also allows you to roam freely and ask questions, to find out how the organisation ticks and discover some of the personal dynamics around the Council table.

Finally, the society is a collaborative effort between the staff and the fellowship and it cannot do what it does without both. So my advice to younger geologists, be they professional or academic, is to get involved. Many is the time I have heard 'what do I get for my annual subscription?' My response, to paraphrase J. F. Kennedy, is: 'Ask not what the Society can do for you but what you can do for the Society'. My own personal experience has been that getting involved has been far more rewarding than I would have imagined at the outset.

FROM THE LIBRARY

While our building is closed, the GSL Library staff are here to support our Fellows, Friends, Corporate Patrons and other researchers. For more information about Library services or if you have any enquiries visit www.geolsoc.org.uk/library, email library@geolsoc.org.uk or call us on +44 (0)20 7434 9944 (option 3).

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- Database searches - we can search the GeoRef and Geofacets databases on your behalf and send you lists of references

Additional online resources during COVID-19 closure

We have created a new page on our Virtual Library bringing together extra online resources which a number of publishers and organisations have made available to support the geoscience community at this time, including e-book collections and the AGI Glossary of Geology. Find out more at www.geolsoc.org.uk/Library-and-Information-Services/Virtual-Library/additional-online-resources-covid-19

Picture Library

Discover hundreds of images from our historical collections on our Picture Library. Whether it's the fossils discoveries of Mary Anning, beautiful geological maps, or even the world's largest pearl, there is something for everyone! www.gslpicturelibrary.org.uk

Online exhibitions

The Library's online exhibitions highlight various treasures from the Geological Society's special collections, and shed light on some of the most important figures in the history of geology. Our new exhibition, The First Women, celebrates just a few of the firsts achieved by women in both the science of geology and at the Geological Society. www.geolsoc.org.uk/Library-and-Information-Services/Exhibitions

Library newsletter

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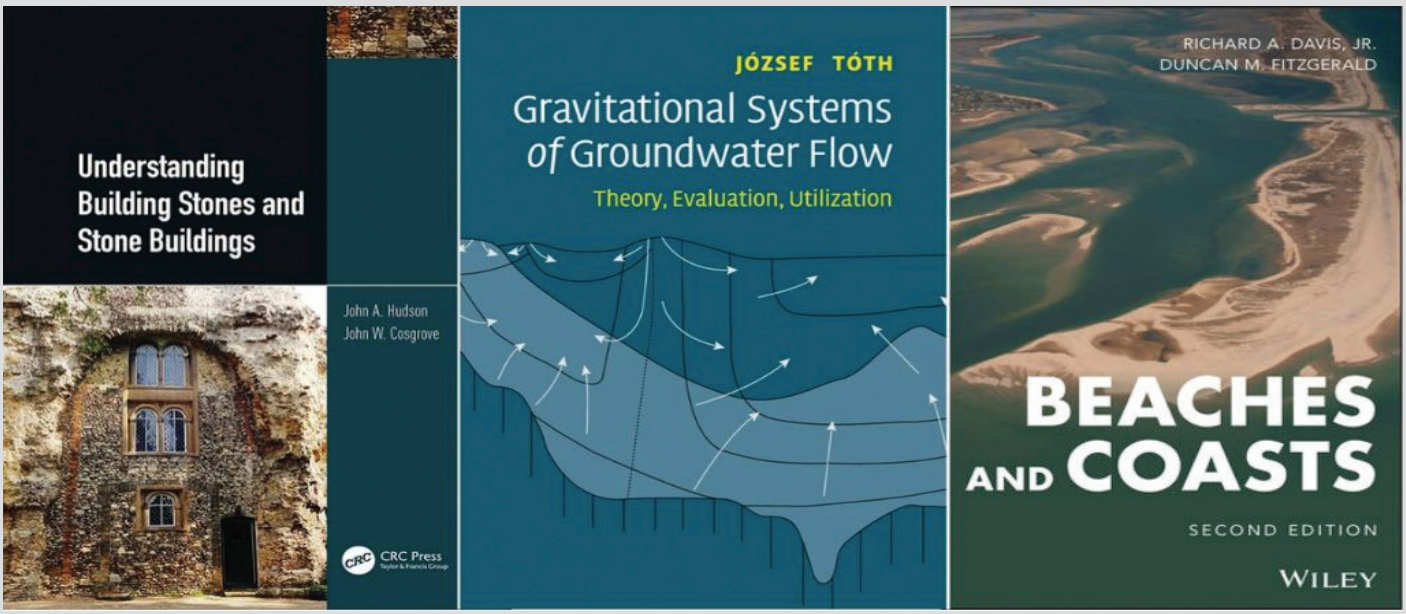
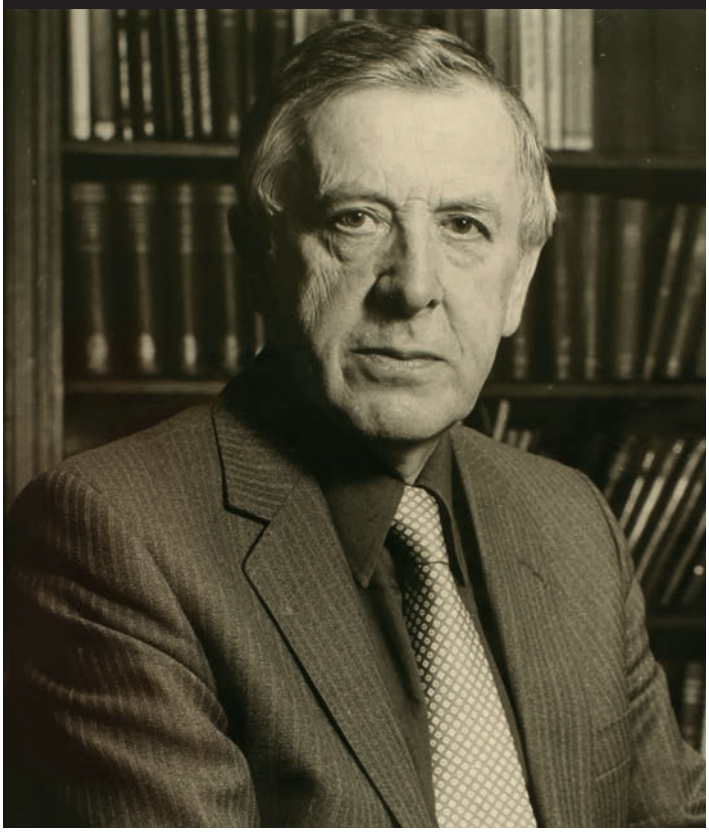


OBITUARY Charles Hepworth Holland (1923-2019)

Eminent Professor of Geology and Mineralogy who co-founded the Ludlow Research Group



Charles Holland was a born organiser and committee chairman, who rose to eminence in several fields of geology, notably including Presidency of the Geological Society from 1984 to 1986.

Manchester and the Ludlow Research Group

He was born on 30th June 1923 at Stockport, Lancashire, and, after WW II service in the air force, read geology at Manchester. A key figure there was S.H. Straw, who kindled Holland's interest in the Upper Silurian, which he mapped for his doctoral thesis around Knighton, Radnorshire.

Several like-minded younger workers including Holland together founded the Ludlow Research Group (LRG) to provide discussion towards a coherent stratigraphical understanding for the whole of the Upper Silurian of Wales and the Welsh Borderland of England. Of those, Holland, J.D. Lawson and V.G. Walmsley combined to remap the Ludlow area itself. Their new stratigraphy was published in a *Nature* paper in 1959 and a more substantial work in 1963, and four stages were erected for the series. From 1962 the scope of the LRG was extended to cover the whole Silurian.

In 1952, Holland became a lecturer at Bedford College, London. He was one of the 67 people at the foundation meeting of the Palaeontological Association, with which he became heavily involved, rising to President from 1974-1976 and being awarded the Lapworth Medal in 2008.

He moved away from his native England in 1966 when he was appointed Professor of Geology at Trinity College, Dublin, which he enlarged to become a vibrant research school. He went on to become a leader in Irish geology, including the 1981 publication of *A geology of Ireland*. He remapped the Dingle Peninsula of County Kerry, one of the few Irish places where the Silurian includes shelly fossils.

> CHARLES HOLLAND WAS A BORN ORGANISER AND COMMITTEE CHAIRMAN, WHO ROSE TO EMINENCE IN SEVERAL FIELDS OF GEOLOGY, NOTABLY INCLUDING PRESIDENCY OF THE GEOLOGICAL SOCIETY FROM 1984 TO 1986.

International outlook

His outlook was ever international: he was a member of the Siluro-Devonian Boundary Committee, which stabilised that boundary in 1980 in the Czech Republic. Holland took the lead in organising and formalising the various international divisions within the Silurian System, and was Chairman of the IUGS International Subcommission on the Silurian from 1976 to 1984, which divided the Silurian into four series and eight stages - internationally adopted in 1984. He edited four large volumes on the Lower Palaeozoic Rocks of the World.

The Silurian chart

The Geological Society recognised the need for correlation charts for each system across Britain and appointed Holland to produce the Silurian chart, together with L.R.M. Cocks, R.B. Rickards and I. Strachan. This was completed in 1971, and another team lead by him revised the type Wenlock in 1975.

Holland was particularly active in the study of Silurian cephalopods, many known by the old name of *Orthoceras*, which also led to numerous papers. He was very influential on many Irish committees, not just in Trinity College, and was elected a Member of the Royal Irish Academy. After his formal retirement in 1993, he was designated Emeritus Professor, but his research continued unabated.

Charles died on 26th December 2019: his wife Eileen had predeceased him, but he is survived by his daughter Celia and two grandchildren.

By Robin Cocks

The full version of this obituary can be found online. *Editor*

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Geological Society publications online

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Year of Life Collection

The evolution of life on Earth has been intrinsically linked to the planet's climatic and biogeochemical state for several billion years. From microbes living deep in the crust to Himalayan tardigrades, and from the search for life's origins to predicting the future climate, life has occupied, adapted to and shaped virtually every environment with impacts across the breadth of the geosciences. This collection, part of the Society's Year of Life 2020, aims to collate recent and seminal papers that cover the breadth of geoscience research into the impacts, or the effects of, life on Earth and beyond. Reconstructing ecosystems from the Archaean to the Anthropocene, mass extinctions to the actions of microbes, and from deep sea vents to astrobiology.

Collection Guest Editors

Heda Agić, University of California Santa Barbara, United States of America

William Foster, University College Dublin, Ireland

Sophie Nixon, University of Manchester, United Kingdom

Sean McMahon, University of Edinburgh, United Kingdom

Duncan Murdock, Oxford University Museum of Natural History, United Kingdom

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Find out more about the Year of Life
www.geolsoc.org.uk/life20

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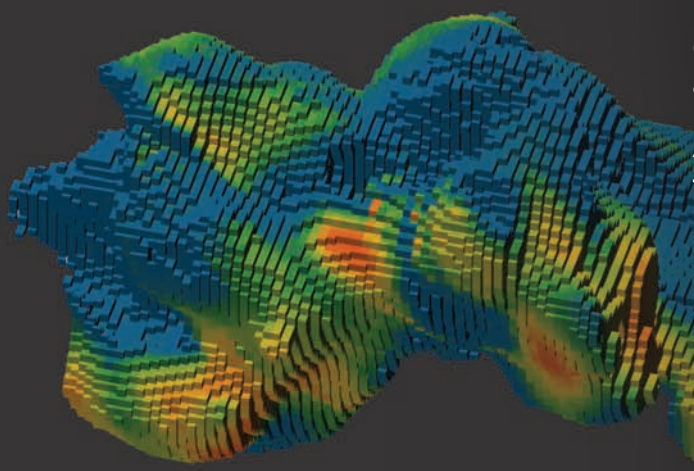
Mineral Resource Estimation:

Recent Advances and Current Best Practice

V I R T U A L C O N F E R E N C E

19 October 2020



In an era of rapid technological innovation, opportunities exist to improve efficiency and quality of resource estimates, both developing trust and encouraging investment in mining projects. This conference aims to provide a forum for resource estimate practitioners to meet and discuss new developments and advances in mineral resource estimation and reporting.

As part of the conference, we will explore topics from the following broad areas:

- **Exploratory data analysis:** analysis of geoscience data prior to use in a MRE including databasing, data quality analysis, utilising 'big data', and methods of critical evaluation.
- **Geological modelling:** methods and processes used for generating 3D models of geological features, including software advances and comparisons, how to integrate 'big data' and busting commonly encountered myths.
- **Geostatistics and grade estimation:** methods for estimating tonnage and grade/quality of a mineral deposit, including recent software advances, new techniques and comparisons of techniques in different mineralization types. Reconciliation between estimates and production, to ground truth models.
- **Resource reporting:** methods used for generating Mineral Resource statements, including methods for demonstrating 'reasonable prospects for eventual economic extraction' (as defined in international reporting codes), including updates/comparisons of CRIRSCO standards, new ESG requirements and participating committees.

Co-Convenors and Keynote Speakers

Ben Lepley Senior Resource Geologist

Lucy Roberts Principal Resource Geologist

James Catley Resource Geologist

Further information

For further information please contact:

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The Geological Society,
Burlington House, Piccadilly,
London W1J 0BG

T: 0207 434 9944

E: conference@geolsoc.org.uk

Web: www.geolsoc.org.uk/events

Follow this event on Twitter: #gslminerals20

Call for papers

We invite oral abstract submissions for the meeting, and these should be sent in a Word document to conference@geolsoc.org.uk by **Friday 21st August 2020**. Abstracts should be approximately 250-350 words and include a title and acknowledgement of authors and their affiliations.