GEOSCIENTIST

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The Fellowship Magazine of the Geological Society of London

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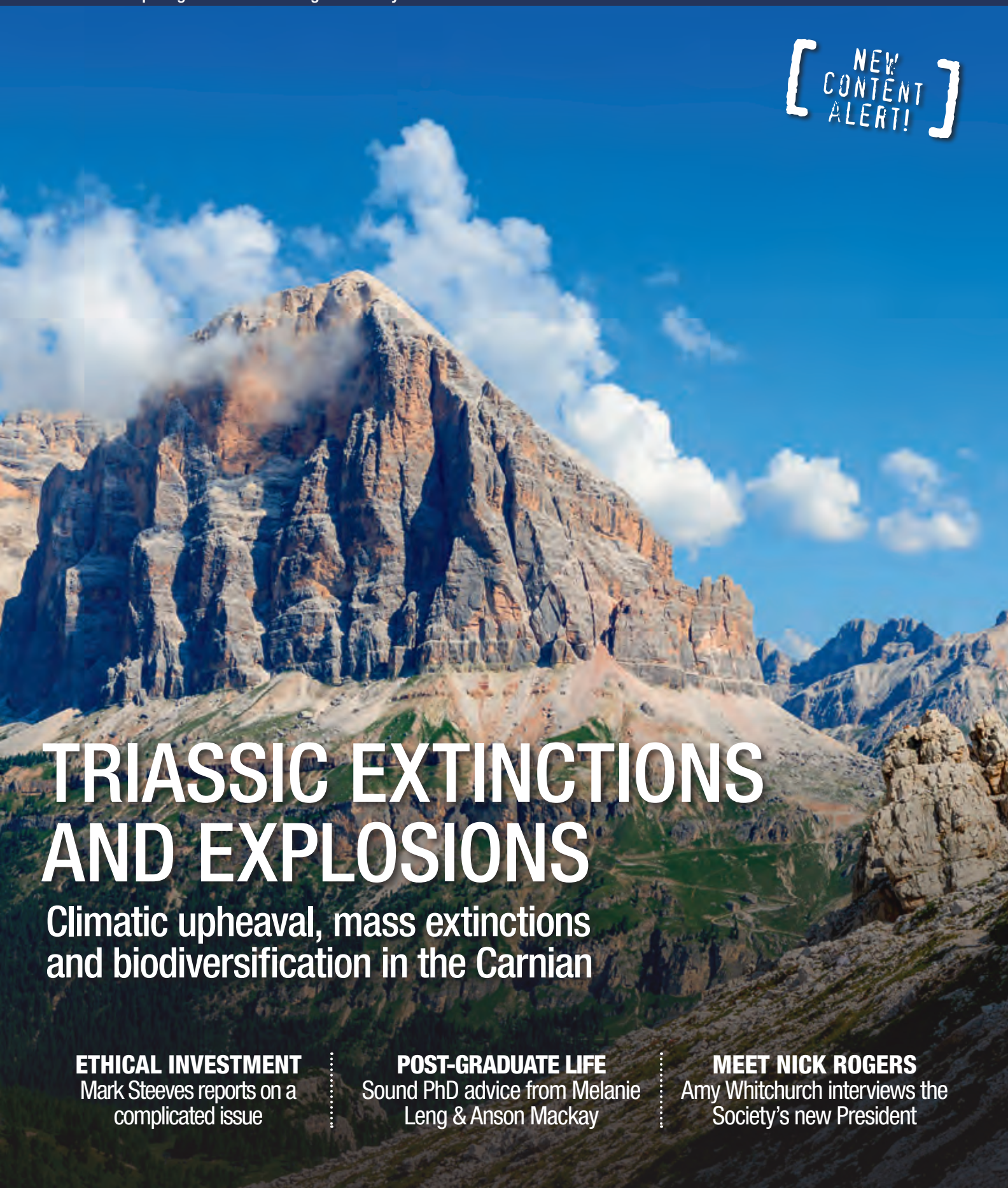

[NEW CONTENT ALERT!]

TRIASSIC EXTINCTIONS AND EXPLOSIONS

Climatic upheaval, mass extinctions and biodiversification in the Carnian

ETHICAL INVESTMENT
Mark Steeves reports on a complicated issue

POST-GRADUATE LIFE
Sound PhD advice from Melanie Leng & Anson Mackay

MEET NICK ROGERS
Amy Whitchurch interviews the Society's new President

Red alert for the Sumatran tiger. Fauna & Flora International seeks action from Geoscientist readers in response to severe threat from poachers. 30 September deadline.

Photo: Brian McKay

This Critically Endangered tiger has been pushed to the edge of extinction – 350 or fewer remain. Give to stop the poachers at www.FFIsumatrantiger.org

350 Sumatran tigers remain - down from 500. Urgent support needed for action plan. We must act now to save them.

- **£83,131 is needed to help us fund more rangers and step up action against the poachers in Kerinci Seblat National Park.**
- **This is one of the final strongholds of the incredibly rare Sumatran tiger.**
- **FFI's work here could be all that stands between the Sumatran tiger and extinction.**

Latest figures show 350 Sumatran tigers remain - down from 500. The figures, from the Sumatran Ministry of Forestry, show how the ruthless assault from poachers is pushing this magnificent creature right to the edge of extinction.

Fauna & Flora International (FFI) has put out an urgent call to the global community to save the last Sumatran tigers currently existing in the wild – and specifically to employ more rangers.

FFI is urgently seeking funds to step up their crucial conservation programme in Kerinci Seblat National Park, Sumatra, Indonesia. In order to safeguard the future existence of these magnificent creatures, it is vital that more rangers are employed.

Right now, the Sumatran tiger faces a number of very serious threats, which are putting their very survival in jeopardy. And, sadly, they are all man-made.

Poaching activity has reached unprecedented levels. Hunters make good money from the tiger's beautiful skin and demand is constantly growing. FFI's investigations show that there is a huge demand for tiger bone, which is used in traditional Asian medicines, and black market prices make this grisly trade all too profitable.

These grave threats have been exacerbated by a very serious loss of habitat. In the last ten to 15 years, natural forest cover in Sumatra has been slashed by almost a staggering 40%.

With such a dramatic loss of habitat, these majestic forest dwellers are struggling to survive and have been designated as Critically Endangered on the IUCN Red List, making the Sumatran tiger one of the most endangered tiger subspecies on the planet. This is a rating reserved for animals that face an extremely high risk of extinction in the wild.

Latest surveys have indicated that there may now be as few as 350 Sumatran tigers existing in the wild. Thanks to the vital work of FFI's Tiger Protection and Conservation Programme, the numbers have stabilised in the Kerinci Seblat National Park, but the species is still under severe threat.

The illegal poaching syndicates are ruthless and will stop at nothing to supply the market. Other poachers are also in the area, sabotaging FFI's conservation work. In 2016, bird poachers vandalised 16 camera traps set by the tiger conservation team, which meant vital evidence was lost.

This is an ongoing battle, but it is one we must win. Debbie Martyr, FFI Team Leader of the Kerinci Tiger Project in Sumatra, says:

"Ranger teams walked almost 1,100 miles on forest patrols in and bordering the national park and destroyed more than 16 active tiger snares. That is why we need to step up patrol regimes".

Tiger populations are dreadfully fragile.

The signs suggest that FFI's approach is working, as patrols are reporting more evidence of tigers. Yet if FFI cannot recruit more rangers to protect the tigers against the increased efforts of the poachers, then all our good work could be undone.

That's why it's absolutely vital that we increase our patrols to protect tigers from poachers – and work towards greater protection for their delicate habitat.

If we're going to save the Critically Endangered Sumatran tiger from complete extinction, it's crucial that we have the means to take action now.

FFI must raise £83,131. To do that, the charity is asking Geoscientist readers to make an urgent contribution today.

Photo: Gary Morrisroe/FFI

"If you value the natural world – if you think it should be protected for its own sake as well as humanity's – then please support Fauna & Flora International."

Sir David Attenborough
Fauna & Flora International vice-president

Please send a gift, by no later than 30 September to help safeguard the future survival of the last few remaining wild Sumatran tigers.

Together, we can save the Sumatran tiger from extinction – but only if we take action immediately.

To take action for the Sumatran tiger please go to www.FFIsumatrantiger.org or cut the coupon.

If the coupon to the bottom right is missing, please send your cheque (payable to FFI) to: Freepost FAUNA & FLORA INTERNATIONAL by 8 January at the very latest.

Photo: Debbie Martyr/FFI

FFI is driving down wildlife crime, and in conjunction with local police, is successfully investigating and arresting wildlife criminals. Your support today can help stop the senseless killing of Sumatran tigers and their cubs.

Dear Geoscientist readers: Fauna & Flora International (FFI) has launched an emergency appeal, backed by Sir David Attenborough, to raise £83,131 to save the Sumatran tiger.

These items are vital to help save the remaining Sumatran tigers from extinction.

£6,500 could buy a replacement 4WD jeep to transport rangers to distant patrol sites - our current vehicle has severe engine problems.

£3,000 could help get two extra rangers into the field to prevent poaching.

£400 could buy camping equipment or boots for 28 rangers.

£72 could buy first aid kits to treat injured rangers whilst out on patrol.

£32 could help buy charging units for telephones; essential to getting extra help if poachers are spotted.

Donations large or small will help us save the Critically Endangered Sumatran tiger from illegal poaching syndicates.

Cut the coupon below and return it to FFI, together with your gift, to help save the Critically Endangered Sumatran tiger. Alternatively, go to www.FFIsumatrantiger.org. Thank you.

I want to help save the remaining 350 Sumatran tigers today, with a donation of £_____

Title Forename

Surname

Address

Postcode

Please email me with updates, appeals and events at:

☐ I enclose a cheque to **Fauna & Flora International** OR
☐ I wish to pay by credit/debit card

Card No:

Expiry Date: Security code:

Issue Number: (Maestro only)

See the difference you have made

To show how your support has helped, we will keep you informed on the progress of this project and our other work around the world to protect endangered species by mail. We will also send you carefully selected projects where your support could make a difference. If you don't want this information please tick the box below.

☐ Please don't contact me by post

We keep your personal details secure and never sell, trade or rent them out.

See full details at www.fauna-flora.org/privacy

Please return to: Freepost FAUNA & FLORA INTERNATIONAL, The David Attenborough Building, Pembroke Street, CB2 3QZ or go to www.FFIsumatrantiger.org to donate online now.

Please note: If Fauna & Flora International succeeds in raising more than £83,131 from this appeal, funds will be used wherever they are most needed
Registered Charity Number 1011102 Registered Company No. 267706.

Registered with FUNDRAISING REGULATOR

FAUNA & FLORA INTERNATIONAL

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The Geological Society,
Burlington House, Piccadilly,
London W1J 0BG
T +44 (0)20 7434 9944
F +44 (0)20 7439 8975
E enquiries@geolsoc.org.uk
(Not for Editorial - Please contact the Editor)

Publishing House
The Geological Society
Publishing House, Unit 7,
Brassmill Enterprise Centre,
Brassmill Lane, Bath
BA1 3JN
T 01225 445046
F 01225 442836

Library
T +44 (0)20 7432 0999
F +44 (0)20 7439 3470
E library@geolsoc.org.uk

EDITOR-IN-CHIEF
Professor Andy Fleet

EDITOR
Dr Amy Whitchurch
E amy.whitchurch@geolsoc.org.uk

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Century One Publishing
Alban Row, 27–31 Verulam Road, St Albans, Herts, AL3 4DG
T 01727 893 894
F 01727 893 895
E enquiries@centuryone publishing.uk
W www.centuryone publishing.uk

ADVERTISING SALES
Alex Killen
T 01727 739 182
E alex@centuryonepublishing.uk

ART EDITOR
Heena Gudka

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Ryan Gaston

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ON THE COVER:

FEATURES

REGULARS

The Geological Society

serving science, profession & society

Chartership Officer

The Geological Society promotes and implements the adoption of professional standards in the geosciences principally by awarding Chartered status (CGeol and CSci). Chartership demonstrates that an individual is regarded by his/her peers as competent to practice within their chosen field. The Society's Chartership Officer plays a pivotal role in promoting and developing Chartership, facilitating the accreditation process, and responding to enquiries. The Society seeks to appoint a Chartership Officer due to the retirement of the current post-holder.

The successful candidate will need to demonstrate a range of skills, competencies and abilities. S/he will be an Earth sciences graduate committed to the Society's objectives in service of science, fellowship and society. S/he will be a Chartered Geologist or Chartered Scientist, preferably with experience of working as a Chartership Scrutineer. Ideally s/he will be able to demonstrate commitment to Chartered status within the Profession through leadership experience, for example, at the interface between the profession, other professional bodies and non-geologists.

The location is not fixed though frequent visits to the Society's offices at Burlington House, London and other mainly UK locations are required. The post is part-time. The Geological Society is committed to diversity, equal opportunities and inclusion in the work place, and the successful applicant will be expected to embrace and contribute to this environment.

The closing date for applications is October 5th 2018
For further information see www.geolsoc.org.uk/chartershipofficer

The Geological Society of London, Burlington House, Piccadilly, London, W1J 0BG, UK
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Financial Support for Research in Earth Sciences

Geologists' Association

The Geologists' Association can provide financial support of up to £600 to individuals for

Research projects in any area of Earth Sciences

— students should apply for a *New Researchers' Award*
https://geologistsassociation.org.uk/newresearchers/

— non-students should apply for a *GA Research Award*
https://geologistsassociation.org.uk/research-awards/

Support of up to £250 is also available for

Attendance at meetings

— apply for a *GA Meetings Award*
https://geologistsassociation.org.uk/meetings-award/

Applicants should be members of the Association. Limited funds are available for non-members.

The deadline for applications is 15 November each year.

The Geological Society

serving science, profession & society

Conferences and Asbtract Deadlines

New Frontiers in Palaeogeography & Biogeography
21 September 2018
The Geological Society
www.geolsoc.org.uk/palaeogeography18

Regional Public Lecture – Newcastle
Can Abandoned Mines Heat Our Future?
25 September 2018
North of England Institute of Mining and Mechanical Engineers
www.geolsoc.org.uk/abandoned-mines

Seismic Characterisation of Carbonate Platforms & Reservoirs
10-11 October 2018
The Geological Society
www.geolsoc.org.uk/carbonateplatforms18

Bryan Lovell Meeting 2019
Role of geological science in the decarbonisation of power production, heat, transport and industry
21-23 January 2019
Abstract deadline: 1 October 2018
www.geolsoc.org.uk/Lovell19

Celebrating the life of Chris Cornford (1948-2017): Petroleum Systems Analysis 'Science or Art?'
24-25 April 2019
Abstract deadline: 30 September 2018
www.geolsoc.org.uk/PG-Celebrating-the-life-of-Chris-Cornford

Image:Laminated sandstones on Gullane beach © Milena Farajewicz

> *GEOSCIENTIST* AIMS TO BE A RESOURCE FOR GEOSCIENTISTS IN ALL FIELDS AND AT ALL STAGES OF THEIR CAREER

FROM THE EDITOR'S DESK:

Assemblies and occupations

Fellows turn to *Geoscientist* not only for the interesting science, but also to learn about broader developments across fields, and events within and beyond the confines of the Geological Society. To reflect this demand, we're trialling two new content types: *Meeting Report* and *Careers*.

Conferences and meetings are an essential part of a life as a geoscientist. They provide unparalleled networking opportunities and access to the most exciting advances and directions within a field.

But life is busy. We barely have time to keep up with developments in our own areas of expertise, let alone anyone else's. Throughout the year, numerous meetings are held across the globe that we'd like to attend, but lack of time and funds are prohibitive. *Meeting Report* aims to help. Written by a meeting attendee, these reports provide a concise summary of some of the most interesting outcomes of a meeting, as well as some thought-provoking opinion on the topics discussed and future directions for the field.

In our first *Meeting Report*, Mark Steeves discusses a recent City of London Geoscience Forum on the sticky topic of 'Ethical investment in the extractive industries'. The discussions highlight that to raise the living standards of the world's population, it could be considered unethical *not* to invest in the natural resources sector. Conversely, investors have to be more aware of the potentially severe environmental and social consequences of extraction and must share responsibility in this regard.

Meeting Report aims to provide a global perspective. We will consider reports on any relevant Earth science meeting globally, covering pure or applied geoscience—whether run by the Geological Society or not.

The second new section, *Careers*, offers a forum for geoscientists to share their professional experiences and advice with, for example, students, early career professionals, those going through chartership or acting as sponsors. Our Fellowship is a valuable source of knowledge—by sharing advice in the careers section, Fellows can help smooth the path for early career geoscientists following in their footsteps.

We kick off *Careers* with a 3-parter on advice for PhD students. Melanie Leng and Anson Mackay have supervised over a hundred students and have compiled advice on the entire PhD process and beyond. In this issue, they provide essential tips on how to pick a project and supervisor, how to manage the student-supervisor relationship, and the importance of work-life balance. Look out for tips on data management, writing and the transition to post-PhD life in the next issue of *Geoscientist*.

DR AMY WHITCHURCH, EDITOR - amy.whitchurch@geolsoc.org.uk @geoscientistmag

SOCIETY *NEWS*

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

Honorary Fellowship

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

Professor Yildirim Dilek, University Distinguished Professor at the Department of Geology & Environmental Earth Science, Miami University is a conscientious advocate of interdisciplinary and international science, and a major contributor to the global geoscience community. He is not only a highly productive researcher, but he spends a great deal of time and effort serving as a *science ambassador* around the globe.

As a visiting professor in China, Japan, France, Italy, Norway, Turkey, and Albania over the course of the past 20 years, he has given numerous talks and led field many trips. He has helped young scholars and students in these countries with their research projects, both in the field and laboratory, and inspired a large and diverse earth science community around the globe. Therefore, he has done extensive and effective outreach in many countries, particularly in Asia. He exemplifies all the expected traits and qualifications of an Honorary Fellow of the Society and richly deserves to be recognized as such. We believe strongly that Professor Dilek will continue to promote geosciences passionately on different fronts at a global level as an Honorary Fellow of the Society.

Council & OGMs

OGMS: 2018: 18 September, 28 November.
2019: 6 February, 3 April
COUNCIL: 2018: 18 & 19 Sept (residential), 28 November.
2019: 6 February, 3 April

Awards 2019 – make your nominations!

Fellows of the Society are encouraged to submit nominations for the Society's Awards for 2019 to the Awards Committee.

Full details of how to make nominations are on the website at **www.geolsoc.org.uk/About/Awards-Grants-and-Bursaries**. Nominations must arrive at the Society ***no later than noon on 29 September 2018.*** *Stephanie Jones*

PUBLIC LECTURE SERIES

Making the most of minerals: sustaining society sustainably?

Speaker: Simon Redfern, University of Cambridge
Location: Burlington House, London
Date: 26 September

Programme

- **Afternoon talk:** 14:30pm Tea & Coffee; 15:00 Lecture begins; 16:00 Event ends
- **Evening talk:** 17:30 Tea & Coffee; 18:00 Lecture begins; 19:00 Reception.

Can Abandoned Mines Heat our Future?

Speaker: Charlotte Adams, Durham University
Location: North of England Institute of Mining & Mechanical Engineers, Newcastle Upon Tyne
Date: 25 September

Programme

- **Evening talk:** 17:30 Tea & Coffee; 18:00 Lecture begins; 19:00 Reception.

Further Information

Please visit **www.geolsoc.org.uk/gsllondonlectures18**. Entry by ticket only (contact the Society about four weeks before the talk). Due to popularity, tickets are allocated in a monthly ballot and cannot be guaranteed.

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

Nominating colleagues for awards from other societies

To reward excellence and promote international recognition of Fellows of the Society, you are encouraged to nominate colleagues for awards of other societies, such as the American Association of Petroleum Geologists, the American Geophysical Union, the European Geosciences Union and the Geological Society of America. There are different requirements and criteria for the awards made by these societies, for example some require the candidate to be a member. Details can be found at the web links shown below.

www.aapg.org/about/aapg/overview/honors-and-awards
www.honors.agu.org/awards-medals-prizes/
www.egu.eu/awards-medals/proposal-and-selection-of-candidates/
www.geosociety.org/awards/aboutAwards.htm

Earth Science Week 2018

This year's UK & Ireland Earth Science Week is taking place on 13-21 October, with a theme of 'Earth science in our lives', writes Sarah Day.

To mark our Year of Resources, we're highlighting the ways in which geology affects our lives through everyday objects, possessions, products and services, in the home and further afield—often in ways we don't expect. A range of events, from hands on activities to open days, public lectures and geology walks, are taking place across the UK & Ireland. There's still time to organise one where you are—let us know what you have planned, and see the calendar of events so far, at **www.geolsoc.org.uk/earthscienceweek.**

Enter the 2018 Earth Science Week photography competition!

There's still time to enter this year's photography competition! Entry is free, and open to all—send us your images of UK & Ireland geology on a theme of 'Earth science in our lives' by midnight on Tuesday 25th September to be in with a chance of winning cash prizes, as well as having your image featured in our 2019 calendar and exhibited at Burlington House. Find out more on the Geological Society's blog at **http://blog.geolsoc.org.uk/2018/07/17/photocomp18/**

Three Sisters of Glencoe in Autumn' by Milena Farajewicz (2017 photo competition winner)

CEng with the GSL

The Society has decided not to offer CEng. Bill Gaskarth explains why.

Fellows with geology degrees often move, via MSc courses, into geotechnical engineering and a number of CGeol Fellows in engineering geology have changed career so that 'Geotechnical Engineer' is now more descriptive of their role. So, hoping to provide a service to this part of our Fellowship, the Society investigated the possibility of offering CEng to suitably qualified Fellows working as geotechnical engineers. We have Fellows who are FGS CGeol and FGS CSci, and many think it reasonable that FGS CEng would more roundly and accurately reflect the skill-base of the Fellowship.

The title of Chartered Geologist best describes the work of a majority of Fellows. But, a considerable number hold the CEng title (most alongside CGeol), often gained via the Institution of Civil Engineers (ICE) or the Institute of Materials, Minerals and Mining (IMMM). That is, Fellows often have to join an organisation outside of their home professional institution, simply to gain the title. By developing application and assessment procedures, following the requirements of the Engineering Council's UK Standard for Professional Engineering Competence, which would be just as rigorous as those of the IMMM in assessing geotechnical engineering knowledge and experience, the Society hoped to provide a service to Fellows—and when we proposed to offer CEng, many Fellows expressed interest in applying.

This CEng initiative, however, met with strong opposition from the committee of the Engineering Group of the Geological Society (EGGS), GSL representatives of both the Register of Ground Engineering Professionals (RoGEP) and the Ground Forum, as well as the IMMM. The concerns expressed by them are that: CGeol is sufficient for the needs of Fellows in the industry; the industry would not understand FGS CEng; the value of the CGeol and CEng titles would be diminished; a route for Fellows to gain CEng through the IMMM already exists; sufficient demand has not been demonstrated.

In the face of such strong opposition from professional bodies in the ground engineering sector, Council has decided that the initiative not be continued. CGeol is an appropriate title for Engineering Geologists. We hope companies will recognise it more by using this title rather than lumping them into a Geotechnical Engineer group. Perhaps this is something that the EGGS might promote?

Read the full version of this piece in the Chartership Newsletter. *Editor*

Newly Chartered Fellows

CGeol: Edward Ball, Matthew Bond, Giles Bushell, Shaun Clarke, Thomas Critchfield, Laura Donegan, Jenny Ellerton, Richard Ellis, William Foster, Gavin Germaine, Paul Goff, Mark Henderson, Richard Hingston, Claire Howarth, Nnaemeka Iloani, Michael Kelly, Andrew Marshall, Toby Masters, Roberto Melillo, Susan Morgan, Gareth Northam, Benjamin Ogden, Thomas Parkinson, Michael Pickard, James Pitcher, Paul Quinlan, Jonathan Rabey, Thomas Robinson, Christopher Rowell, Paul Sargent, Alexander Stuart, William Synott, James Walker. **CSci:** David Brooks, Mark Deighton

Mentoring Workshops

Learn about mentoring and how to develop effective relationships with mentees at our workshops. Following a successful workshop in Manchester in June, another is planned for October. **Applications must be received by October 5th** (participants limited to 18; if fewer than 10, the event will be cancelled). Detailed follow-up workshops can be arranged (please express interest to the Chartership Officer). **Where & when:** Burlington House, London, October 19th. **Email:** Chartership@geolsoc.org.uk for more information (and see poster online).

Scrutineering events

Calling all new and experienced scrutineers! Meet, refresh your knowledge of assessment procedures and share experiences at scrutineering workshops. Any CGeol who is not a Scrutineer and is interested in joining the panel is encouraged to attend and to consider putting in an application. The events are also valuable to non-scrutineers acting as a sponsor for a Chartership Applicant. **Where & when:** London Sept 20th, Birmingham Sept 27th, Manchester October 4th. **Time:** 18.00-20.00. **Email:** Chartership@geolsoc.org.uk for more information.

GSDG Programme: 2018

The Geological Society Discussion Group meets at 18.30 for 19.00, when dinner is served. Attendance is open to all Society members.

- **Wednesday 19 September –** Burlington House, Piccadilly (David Shilston on "Triumph and Disaster – the effective use of case histories")
- **Wednesday 24 October –** Bumpkins, South Kensington (John Simmons on "Geological disposal of Radioactive waste: issues in the UK")
- **Wednesday 5 December –** Athenaeum, Mayfair

For information and reservations, contact Sarah Woodcock **E:** sarah.woodcock@geolsoc.org.uk **W:** www.geolsoc.org.uk/Groups-and-Networks/Specialist-Groups/Geological-Society-Discussion-Group

Latest news from the **Publishing House**

Jenny Blythe has the latest from the Geological Society Publishing House

Proving a landslide: ground behaviour problems at Pissouri, Cyprus

By Gareth James Hearn, Hayley Larkin, Kleopas Hadjicharalambous, Artemios Papageorgiou and Georgia Elina Zoi

The residential area of Limnes in Pissouri, SW Cyprus has experienced significant ground behaviour problems since heavy winter rainfall in 2011/2012. These problems have comprised cracking and displacement to the ground, pavements, roads, walls and buildings, leading to the abandonment of the most seriously-affected houses. Nicosia marl comprises the underlying lithology, a material that is associated with volume change upon wetting and drying and has led to foundation problems elsewhere in the country. Various explanations have been given to account for the observed phenomena at Limnes, including the effects of underground water, settlement, slope instability, cyclical shrink-swell, seepage erosion and dissolution. Raised water tables, caused by residential waste-water discharges, applied loads from residential buildings, and inadequate ground investigation and foundation design, are other contributory or causal factors that have been cited.

➤ **Read full abstract and paper in the Lyell Collection** https://doi.org/10.1144/qjegh2017-134

The Carnian Pluvial Episode and the origin of dinosaurs

By Michael J. Benton, Massimo Bernardi and Cormac Kinsella

We present new evidence for a major inflection point in the history of tetrapods on land, a jump in the diversification of archosauromorphs, primarily dinosaurs, at 232–230 Ma. This corresponds to a long-noted changeover in Triassic terrestrial tetrapod faunas from those dominated by synapsids, many of them holdovers from the Permian, to those dominated by dinosaurs. The dinosaur explosion is shown here to correspond in timing to the Carnian Pluvial Episode (CPE), dated at 232 Ma, a time of increased rainfall and perturbation of oceans and atmospheres, followed by substantial aridification. The rock record through the CPE confirms that this event shared many characters with other mass extinctions driven by eruption of large igneous provinces, in this case the Wrangellia flood basalts of the west coast of North America. If this was a catastrophic extinction event, then the environmental perturbations of the CPE explain the sharp disappearance of various terrestrial tetrapods, and the subsequent sharp rise of dinosaurs and perhaps other clades too, especially those that constitute much of the modern terrestrial faunas, such as lissamphibians, turtles, crocodiles, lizards and mammals.

➤ **Read more here** http://jgs.lyellcollection.org/content/early/2018/06/18/jgs2018-049

Where do you think you are?

Richard Langford ponders our increasing positional precision

Remember taking your first GPS unit out of the box? That was the beginning of the end for dodgy base maps and uncorrected aerial photographs. If you remember Bill Clinton removing Selective Availability—the intentional degradation of public GPS signals to aid national security—in 2000, you would soon realise that those maps and photos were an encumbrance, not an asset. Ironically, GPS uses a position-finding method that I was taught as an undergraduate—triangulation.

The art of triangulation is a slow, but pleasingly accurate way of position fixing, only if the three lines form a neat little triangle. Sitting on an exposure in the middle of a field in the Welsh Borderlands, Silva compass in hand, calculating my position was much more of a challenge than recording what I was sitting on.

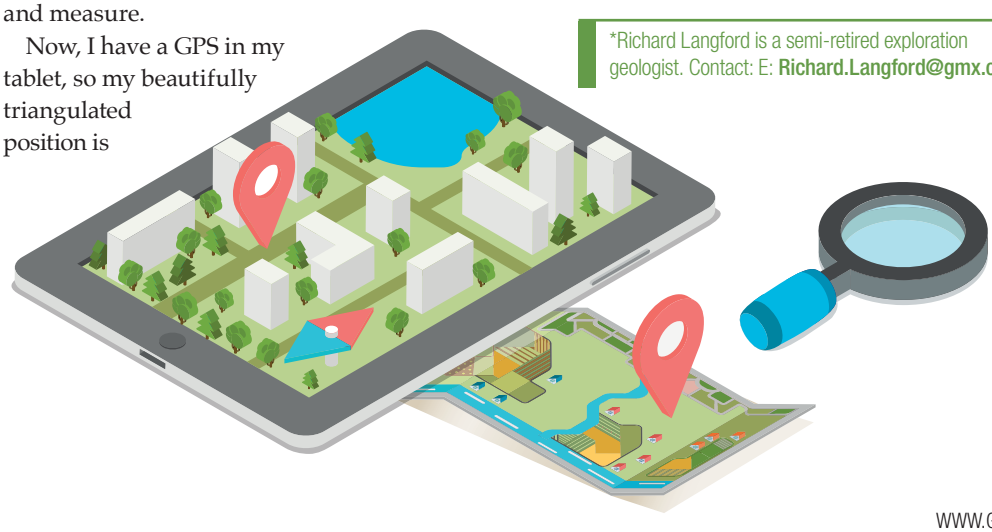
Satellite triangulation now gives me coordinates, and satellite imagery has become more reliable for positioning, with Landsat and SPOT satellite measurements eclipsed by Google Earth/Digital Globe images. Until recently one aspect did not change: I still had to transfer the coordinates from GPS to notebook, and draw a little cross on the photo. Only then could I take time to look at the rocks. Clearly the world was topsy turvy, as where I thought I stood took precedence over what I was there to observe, sample and measure.

Now, I have a GPS in my tablet, so my beautifully triangulated position is captured with a click, sitting on an orthophotograph, backed up with a high-resolution digital elevation model. Another click and I can start typing my notes. The tablet can also record the dip and strike of any surface it sits on. Where I think I am is now relegated to its rightful place in subservience to my primary function as an observational scientist. But do I really know where I am?

We have been seduced by the speed and precision of GPS, ignoring the fact that it is often no more accurate than manual triangulation. But where you think you are will take on a new dimension over the next decade, as differential GPS converges with GPS. The Galileo satellite will get measurements in Europe down to 1 m (1 cm for a fee). Australia is spending A$255 million to obtain a precision of 3 to 5 cm for areas with mobile phone coverage, and up to 10 cm elsewhere. The enhanced GPS system will continuously correct positioning data to take account of Australia's drift north-eastwards at a rate of about 7cm a year.

In the end, does it matter where you are, or think you are? A concern that used to occupy a significant part of a geoscientist's time is now not only hidden in the background, but is also becoming alarmingly accurate. Next time you take a photograph in the field, think carefully about the position you record, and not just the precision of those coordinates. Is your position that of the observer, or the subject? Not long from now, that choice will matter.

*Richard Langford is a semi-retired exploration geologist. Contact: E: Richard.Langford@gmx.com



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 **amy.whitchurch@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).

> "WHERE YOU THINK YOU ARE WILL TAKE ON A NEW DIMENSION OVER THE NEXT DECADE, AS DIFFERENTIAL GPS CONVERGES WITH GPS
>
> RICHARD LANGFORD

TRIASSIC EXTINCTIONS AND EXPLOSIONS

Alastair Ruffell*, **Jacopo Dal Corso** and **Mike Benton** discuss the links between climatic upheaval, mass extinctions and a subsequent explosion in biodiversity during the Late Triassic

The Carnian Pluvial Episode (CPE) of the Late Triassic, 232 million years ago was a time of major volcanic eruptions, sudden changes in global climate and extinctions. These changes seemingly triggered an explosion of many modern groups of animals in the sea and on land. Oddly though, this episode is little understood and was only recently identified as a mass extinction on a par with other, more famous events of the Phanerozoic.

The palaeoenvironmental change was not spotted previously because of general problems in correlating Late Triassic rock successions from continent to continent, but also because the change occurs in the middle of a stratigraphic stage—many other mass extinctions have long been identified with much more ease because they mark major changes that were used to identify boundaries, such as the end Permian, the Triassic-Jurassic Boundary and Cretaceous-Tertiary Boundary.

Dating methods and databases have improved. Importantly, correlations between Late Triassic continental red beds and marine limestones are facilitated by magnetostratigraphy, carbon-isotope excursions, palynology and occasional radioisotopic dates. Critical to development of the theory of the CPE as a mass extinction event is comparison of the marine Tethyan limestones of the Alps with the largely unfossiliferous Keuper/Mercia mudstone successions of North-West Europe. There are still many debates, but remarkable consensus has been reached on high-precision dating of parts of the classic red-bed successions of North

> ABOUT 232 MILLION YEARS AGO, THE DINOSAURS DIVERSIFIED EXPLOSIVELY, SO THE CPE ESSENTIALLY MARKS THE BEGINNING OF THE 'AGE OF DINOSAURS' AND THEIR 165-MILLION-YEAR RULE OF THE EARTH

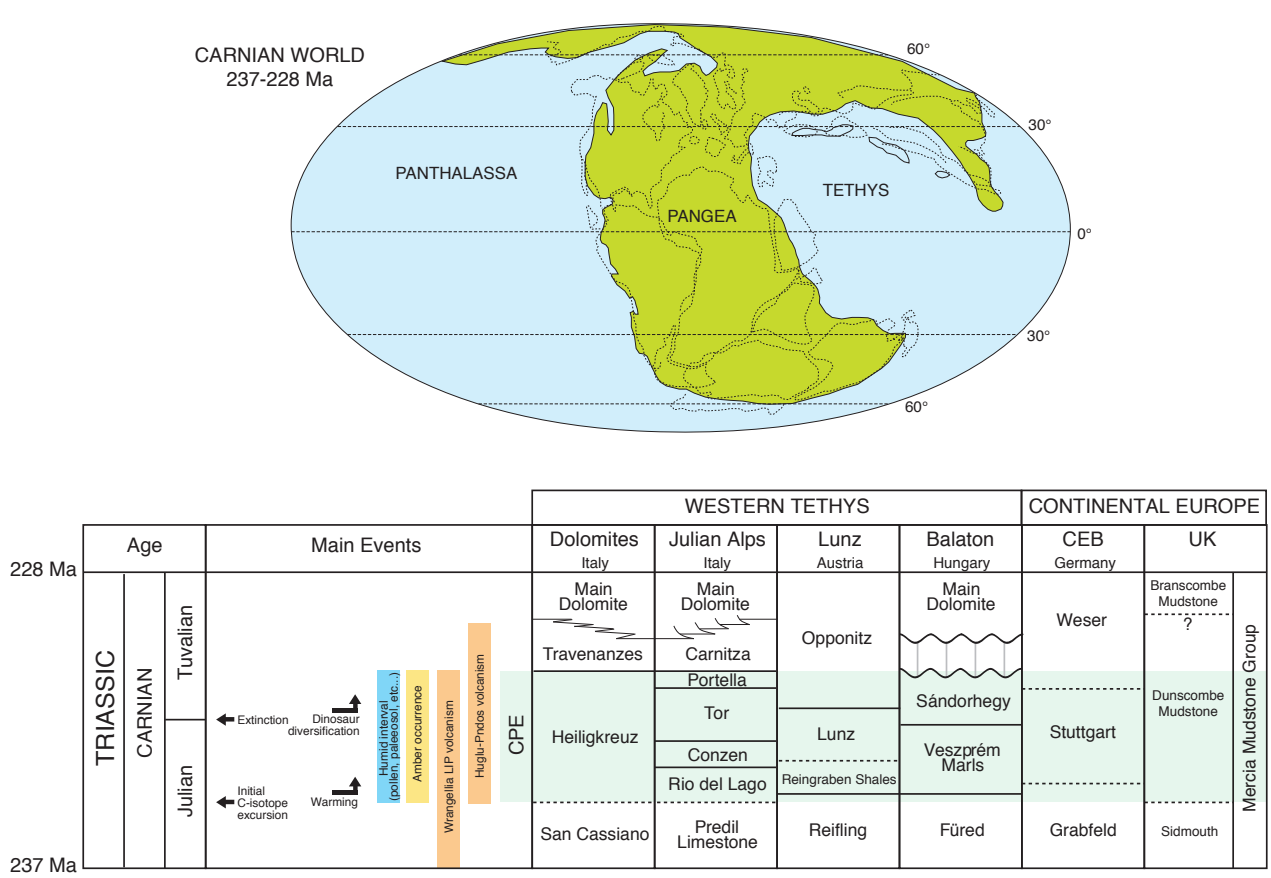


Fig. 1: Palaeogeography of the Triassic Carnian (upper) and correlation of the main events discussed with the marine and non-marine successions of Europe, where the primary evidence for this global climate change was first found. CPE (light green highlight) = Carnian Pluvial Episode; CEB = Central European Basins

America (e.g. the Newark Supergroup, Chinle Group, Dockum Group) and contemporaneous, dinosaur-bearing successions in South America. Key events in the evolution of dinosaurs and other terrestrial groups can now be correlated with marine successions with much more confidence than even five or ten years ago.

This all matters because, about 232 million years ago, the dinosaurs diversified explosively, so the CPE essentially marks the beginning of the 'age of dinosaurs' and their 165-million-year rule of the Earth. Further, and perhaps unexpectedly, this time also marks the origin or initial expansion of nearly all modern tetrapod groups, including turtles, crocodiles, lizards, and mammals. The oceans also underwent a depositional revolution, prompted by extinctions and the radiation of carbonate-forming organisms.

The hidden extinction

The CPE extinction was identified tentatively back in 1986, and the evidence for a climatic flip-flop from arid to humid, and back to arid conditions was proposed in 1989. Yet, this critical episode, which coincides with the explosion of dinosaurs and of so many modern groups, had largely gone unremarked.

In the 1980s, Mike Benton spotted that dinosaurs seemed to diversify in the Triassic. In a 1983 paper, he suggested that it followed a time of climatic and floral change. A catastrophic extinction of dominant herbivorous reptiles, such as rhynchosaurs and dicynodonts, maybe associated with the rapid decline of their favoured seed ferns and replacement by arid-climate conifers. In a 1986 paper (see Further Reading), it was noted that there were actually two mass extinctions in the Late Triassic, one during the Carnian, now dated at 237 to 227 million years ago, and the second at the Triassic-Jurassic boundary.

In 1989, Simms and Ruffell identified increased humidity during the Late Triassic as a pluvial episode, also known as the Carnian Pluvial Event and 'Triassic Wet Intermezzo'. The latter term has a legacy dating back to 1963, when Schlager and Schollenberger named the shales that abruptly overlie Triassic reef limestones in the Alps as marking the 'Rheingraben Turnover' ('CPE' on Fig. 1). Later interpreted as reef drowning, it was the identification of coeval sandstones, such as the 'Schilfsandstein' of the Stuttgart Formation/Arden Sandstone of the North-West European and especially Germanic basins (Fig. 2, Fig. 3-online), fossil cave-fills in the Mendips of ▶

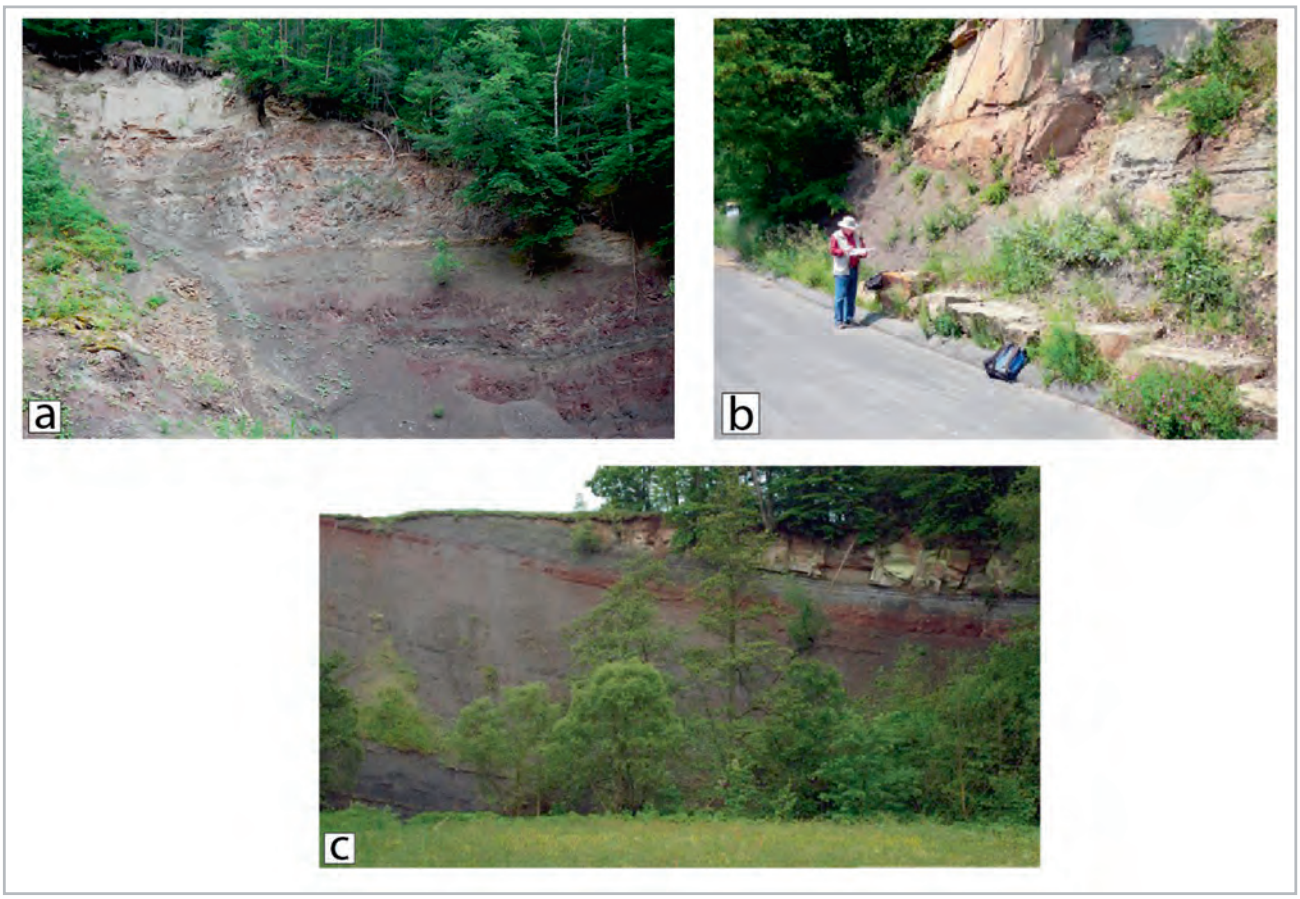


Fig. 2.: The Schilfsandstein (Stuttgart Formation) in central southern Germany. Grey Schilfsandstein (incised) above grey and red Estheria beds (Grabfeld Formation). a, Farnersberg: abandoned clay pit, quarry face ~30 m high. b, Iphofen: road cut, Gerhard Bachmann for scale. c, Bodenmühle: natural outcrop. Images courtesy of Matthias Franz, Georg-August-Universität Göttingen. Full caption online

Fig. 4: Rifugio Dibona section (Tofane, Dolomites, Italy). Here the Heiligkreuz Formation contains "humid" palaeosols with abundant amber. Photo: Jacopo Dal Corso

England and a biotic turnover, especially in marine organisms, that pointed to the idea of increased precipitation, which is the cornerstone of the current theory. Such change is now recognised in many Triassic successions throughout the Northern Hemisphere, as well as some in the Southern Hemisphere, but had at its core, four locations: the Italian/Austrian Alps; the Dolomites; the Germanic/North Sea basins and southern England. Here we use evidence from these areas to document the historical and scientific progress of the humid theory.

The climate change theory has had its critics, from those suggesting the Late Triassic rivers were isolated and not widespread, through to those sticking to the 'turnover' idea (regardless of its origin), to others suggesting eustatic control. In 2012, the discovery by Jacopo Dal Corso and colleagues of a global carbon-cycle perturbation at the onset of the climate change and its possible link to large igneous province (LIP) volcanism reinvigorated the debate. Interest in Carnian environmental and biotic change started to increase rapidly, and already the idea has generated over 50 publications since 1989, with most coming after 2012.

A thematic edition of the *Journal of the Geological Society of London* is imminent and a study group dedicated to discussing Late Triassic changes meets annually at the Hanse-Wissenschaftkolleg, Institute for Advanced Study (Delmenhorst, Germany). Results from advanced sedimentary geochemical, chronological, sedimentological and palaeontological techniques are converging to indicate catastrophic changes at 232 Ma, driven by LIP eruptions such as Wrangellia (Alaska), as well as volcanic eruptions globally (e.g. the Huglu-Pnodos eruptions of Turkey and Greece; Fig. 1), triggering massive climatic and ecosystem upheaval worldwide, in the sea and on land.

Palaeoclimatic Change

The CPE was not a single event, but instead lasted about 1.2 million years and was composed of four to six phases, according to analyses of black shales in the Italian Alps and carbon isotopes in the Mercia Mudstone Group (southern England).

Different lines of evidence point to a more humid climate during this 1.2-million-year episode: initial evidence came from the deposition of sometimes coarse siliciclastic bodies in generally fined-grained and evaporite-bearing continental and marginal marine environments; a broad, Nile-like river is thought to have flowed through the Keuper and Mercia landscape of what is now North-West Europe, while flash floods occurred in Iberia and north Africa; humid conditions are thought to have extended into the Panthalassic Ocean (now Japan); palaeosols that today typically develop in tropical humid environments have been found fossilised in the successions of the Southern Alps (Italy), Meseta (Spain), and Utah (USA); and semi-permanent, grey lake deposits replace ephemeral red-brown fluvial/lacustrine sediments in the Newark Basin (eastern USA and Canada) and humid soils developed in the south and central USA (current states of Utah and Arizona).

Other evidence comes from fossil pollen and spores extracted from Carnian rocks. In 2004, Guido Roghi showed an increase of hygrophytic spores related to more humid climatic conditions during the Carnian in the Cave del Predil area of the Italian Julian Alps—findings confirmed by subsequent palynological studies from different geological settings throughout North-West Europe and beyond (e.g. Svalbard in Arctic Norway).

This idea of increased humidity influencing sedimentary changes and biotic evolution through the Triassic has become cemented in our understanding of Mesozoic palaeoenvironmental change and gained popular currency (e.g. 2 million views of the PBS Eons YouTube presentation 'The Chronicles of Carnia'). But, all was not green and lush in the Carnian world: evaporites and arid conditions persisted at times and in some areas. The CPE theory is centred on European successions, with some evidence for humid conditions appearing elsewhere (Fig. 1), it is currently unclear whether the CPE was truly global.

However, the observed increase in humidity was contemporaneous with a 4 to 7^{0}C rise in sea-surface temperatures, as calculated from oxygen isotopes measured in conodont apatite, suggesting a Greenhouse Earth scenario for the CPE. This hypothesis is strongly supported by carbon-isotope geochemistry, which shows major negative shifts recorded in both terrestrial and marine organic carbon, and carbonate carbon during this time of increased humidity. Such a pattern indicates that large quantities of isotopically light carbon were transferred into the atmosphere, increasing pCO_2 levels, causing global warming and enhancing the hydrological cycle. As for other similar episodes in Earth's history (e.g. the end-Permian mass extinction and eruption of the Siberian Traps), a synchronicity between the carbon-isotope disruption and the eruption of LIPs suggests a cause-and-effect relationship. Global warming can, of course, be triggered by mechanisms other than massive volcanism. For example, the Palaeocene-Eocene thermal maximum is often ascribed to oceanic methane release.

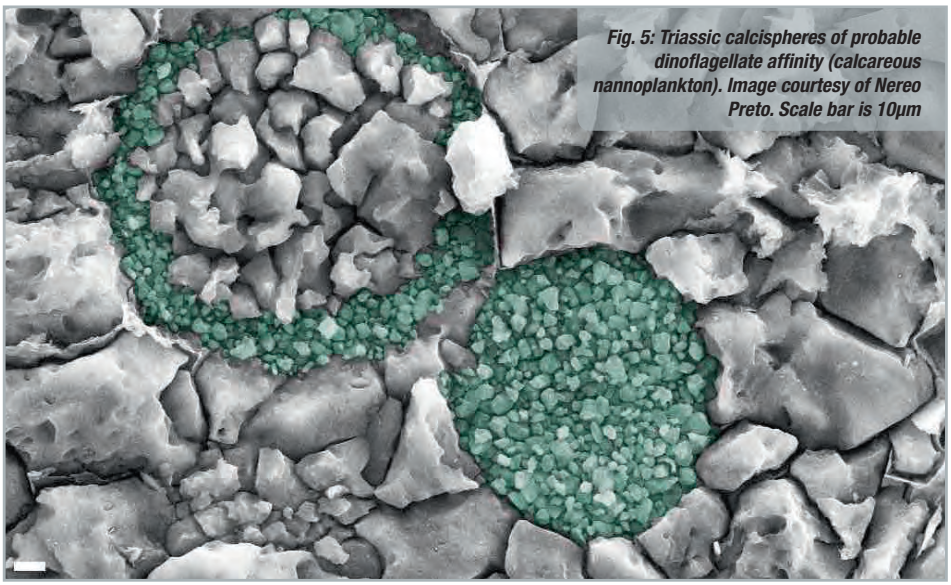


Fig. 5: Triassic calcispheres of probable dinoflagellate affinity (calcareous nannoplankton). Image courtesy of Nereo Preto. Scale bar is 10μm

Carbonate Production

During the Carnian, a Tethys-wide change in carbonate production on platforms is observed in the successions of the European Alps, Himalayas and parts of China. The carbonate factory shifted from highly productive microbial producers to less productive metazoan ramps: often the early Carnian carbonate succession is overlain by shales seen as 'platform drowning' flooding surfaces (Fig. 4). This shift occurred at the same time as the negative carbon-isotope excursion during the onset of the humid episode. In Holocene tropical reefs, a decline of bacterial calcification over the past 12 thousand years has been linked to deglacial ocean acidification. This suggests that the CPE was also marked by brief ocean acidification, the "evil twin" of Anthropocene global warming.

Biotic Extinctions and Radiations

Few studies have focused on marine extinction rates within the Triassic Period, yet the CPE appears to be associated with a major taxonomic turnover. In many different localities, the disappearance of about 70% of conodont genera and important early Carnian ammonoid groups (Trachyceratinae) is observed. In the late 1980s and early 1990s, ▶

Mike Simms linked evidence from the English (Somerset) and German sandstones for increased humidity during the Carnian to the demise of a group of crinoids, the encrinids, from which his remark came "perhaps the crinoids did not like the rain". This may seem an implausible comment, but recently, a functional diversity study led by Alexander Dunhill of the University of Leeds showed that such suspension feeders decreased during the Carnian-probably because of the increased runoff and eutrophication of the sea water, confirming early evidence (Simms & Ruffell, 1989).

Extinction among other groups has not yet been systematically studied, but there is evidence that the climate change could have affected sponges, corals, *Tubiphytes* and bryozoans. The marine extinction was coupled to major evolutionary innovations that determined landmark changes in global ocean chemistry and the carbon cycle. Indications of the first calcareous nannoplankton date back to the Carnian. Recent work showed these first planktic calcifiers (Fig. 5) were probably calcareous dinoflagellates, which become abundant in the late Carnian, and formed a major component (10% of the total rock volume) of pelagic rocks. Paul Bown commented to us that true coccoliths (the main constituents of the Cretaceous White Cliffs of Dover), appeared soon after, in the Norian and Rhaetian. These first rock-forming calcareous nannoplankton marked a revolution in ocean chemistry and ecosystem structure.

This was a change in global carbonate cycles that persists to the present day. The Carnian represents a period of transition from an ocean where carbonate precipitation was dominated by shallow water biocalcification to an ocean dominated by pelagic calcification – from a "Neritan" ocean to a "Cretan" ocean – with the deposition of kilometres of carbonate ooze on the ocean floor. Many workers term this 'A Mid Mesozoic Revolution', starting around the Triassic-Jurassic boundary: the rise of calcareous nannoplankton in the Carnian suggests that the preceding climate change was a major trigger. The evolution of the planktic calcifiers therefore created one of the key elements in the modern global carbon cycle. This acted to produce a much more efficient regulation of marine calcium carbonate saturation state, when reefs dominated by *Tubiphytes* of the early Triassic began giving way to those with scleractinian corals, more like our modern world.

Amber

The first "amber burst" in Earth history is synchronous with the CPE. Carnian amber is found in many localities around the world, the most famous being the amber from the Tofane Group in the Dolomites of northern Italy. Here, abundant amber drops that were probably produced by conifers (Fig. 6) are found embedded in palaeosols and contain important biological inclusions. Microscopic study of amber pieces from the Dolomites by Alexander Schmidt and colleagues at the University of Göttingen offers a unique possibility to look at the rich and diverse Carnian microworld: plant remains, bacteria, fungi, algae, and the oldest amber-preserved arthropods (mites) have been found.

Studies on modern and past plant resins, recently summarized by Leyla Seyfullah and colleagues (in *Biological Reviews*), show that insect infestation, ecological disasters (e.g. hurricane or volcanic eruptions), fire and other stressors can trigger a significant increase in plant resin production. The ultimate reason for increased global amber production during the CPE must be found in the environmental changes of the time: increased seasonal humidity, wildfire activity,

Fig. 6a: Amber droplets from a palaeosol at the Rifugio Dibona (shown on Fig. 4). Each droplet measures a few millimetres. Field of view is 6cm

Fig. 6b: Amber droplet from the Dibona section (Dolomites, Italy). Images courtesy of Guido Roghi, Italian National Research Council

and the release of volcanic gases like SO_2 into the atmosphere could have contributed to stress the flora on a global scale.

Diversification of the Dinosaurs

The origin of the dinosaurs is long-debated. What is agreed is that the Triassic began as a dinosaur-free world and ended with dinosaurs everywhere. The original ideas (from about 1980) were that the Dinosauria arose either through a long process of competitive replacement during the Triassic, or that they more or less exploded onto the scene during the Carnian following an extinction event. There is a bit of truth in both models.

In 1980, the oldest dinosaurs were known from the late Carnian Ischigualasto Formation of Argentina, and age-equivalent rocks in Brazil, India, and the United States. However, it is now agreed that the first dinosaurs trod this Earth at the end of the Early Triassic, 245 Ma. The evidence is tenuous, but multiple: footprints from Poland, a possible early dinosaur from Tanzania, and a definite close sister group dinosauromorph, also from Tanzania.

So, it seems that dinosaurs originated in the Early Triassic (Fig. 7), when so many new groups tentatively emerged during the maelstrom of climate shocks and repeatedly rebuilt ecosystems during recovery from the devastating Permian-Triassic mass extinction. But dinosaurids remained at very low diversity and abundance—almost undetectable—until the mid and late Carnian. The CPE seems to have caused major floral change in Gondwana, with the previously abundant seed ferns being replaced by conifers, which were adapted to the new post-crisis return to arid climates. With the extinction of the seed ferns went the rhynchosaurs—the previously dominant herbivores, squat, pig-shaped animals that may represent up to 80% of tetrapod faunas and have been found from Scotland to Argentina, and from India to Tanzania.

The dinosaurs did not take over immediately. Most of the late Carnian forms were still small carnivores, but some, such as *Herrerasaurus* from the Ischigualasto Formation of Argentina, had become larger, at up to 6 m long. *Herrerasaurus* was a powerful, bipedal beast, capable of preying on all animals of its day. There were also plant-eating sauropodomorphs such as *Saturnalia* and *Panphagia* in South America, but these were only 1.5 metres long and quite rare. Dinosaurian herbivores came into their own during the subsequent, long Norian stage, with giants such as the 5 to 10-m-long *Plateosaurus* found preserved in Germany and *Riojasaurus* in Argentina.

Side-by-side with the new dinosaurs were many other tetrapod groups that would seem familiar today—the first turtles, crocodiles, lizards, and mammals. Admittedly, all of these were rare, but it is intriguing that we can trace most modern land vertebrates to this time of climatic and floral upheaval in the Late Triassic.

After the Carnian episode, marine limestone-dominated and non/quasi-marine 'Keuper' or 'Mercia' style deposition returned (albeit with different biota). This is strange because most revolutions in Earth history show continued changes thereafter, yet it seems the late Triassic mainly returned to how it was. Maybe Pangaea and the Tethyan/Panthalassic oceans were just too vast to allow anything else. ◆

FURTHER READING

A list of selected references may be read in the Online version of this article. *Editor.*

Alastair Ruffell[1]*; Jacopo Dal Corso[2]; Mike Benton[3]

1. Queen's University Belfast, School of the Natural Built Environment, Belfast, BT7 1NN, Northern Ireland.
2. University of Leeds, School of Earth and the Environment, Leeds, LS2 9JT, UK.
3. University of Bristol, School of Earth Sciences, Bristol, BS8 1TH, UK.

* a.ruffell@qub.ac.uk

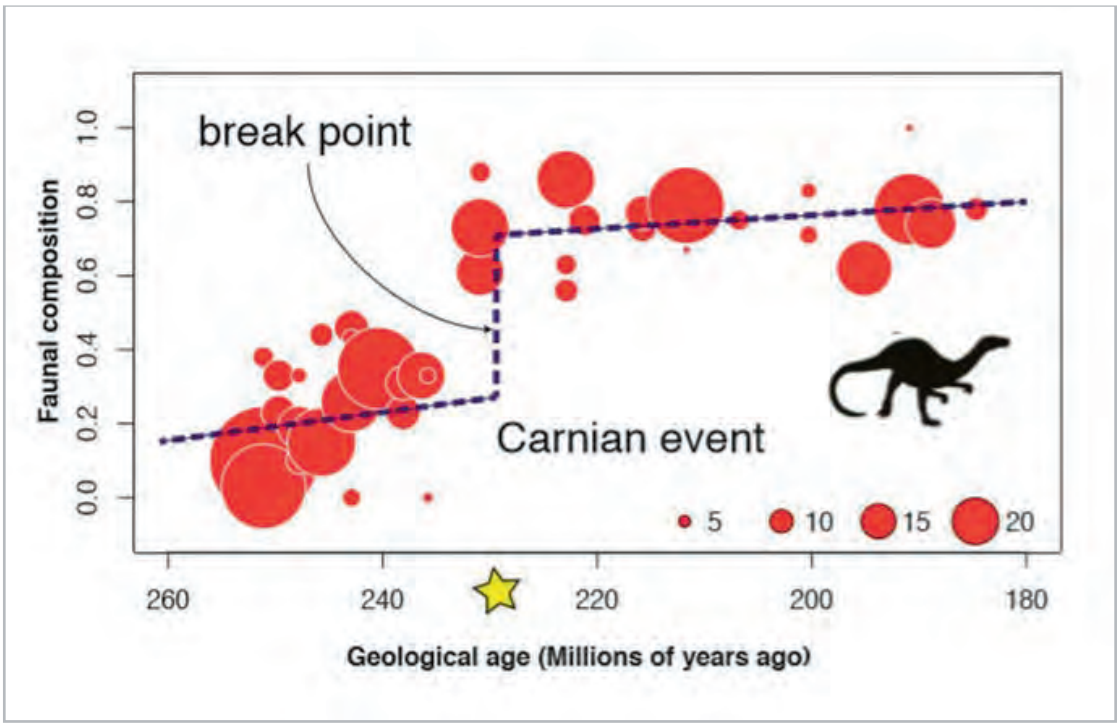


Fig. 7: Tetrapod fauna composition may break ~232 million years ago. Red bubble, separate well-preserved fauna, 5 to 30 genera (bubble size scales faunal size); Y-axis, ratio of dinosaurs and close relatives to all tetrapods (value jumps from ~ 0.2 to 0.75 (average), marking a change in ecology); Dashed line, demonstrates a change rather than data correlation (break point numerical analysis that seeks to fit two lines, with a break at an arbitrary point to best explain the data). The approach reveals a break point in the Carnian, but data could be fit by a curve, suggesting a more gradual transition. Based on data in Benton et al. (2018)

AMBLING IN THE ARCTIC:
THE SKAERGAARD INTRUSION

Victoria Honour relays tales of Arctic foxes, narwhals and the Aurora Borealis during fieldwork mapping of the Skaergaard Intrusion, south-east Greenland

With a population of only 70,000, and a landmass nine times the size of the UK, Greenland remains relatively untouched by human activity. Fieldwork there can be a blissful escape from the 24/7 connectivity of everyday life, and I was very lucky to be given such an opportunity.

My Ph.D. research addresses the physical behaviour of emulsions — mixtures of immiscible liquids — in porous media. Emulsions are widely studied in the petroleum industry and are of great importance for carbon sequestration and food processing, yet little is known about the physical behaviour of emulsions during the evolution of large bodies of molten rock trapped beneath Earth's surface.

Recently, it was shown that basaltic magma may split into two immiscible liquids, one silica-rich and the other iron-rich, during fractionation. The physical properties of the two immiscible liquids are very different, with the silica-rich magma being highly viscous and buoyant compared to its iron-rich conjugate. Furthermore, elements of economic interest, such as gold and platinum-group elements, preferentially associate with the iron-rich conjugate. The chemical evolution of magma and the formation of economic ore deposits are strongly influenced by large-scale mass transport within mush zones in the crust, so we really do need to understand how an unmixed interstitial liquid might behave. One component of my research is an examination of natural examples of gabbroic rocks in which liquid immiscibility played an important role during fractionation: Skaergaard is such an example.

Why Skaergaard?

The Skaergaard Intrusion, on the coast of East Greenland at 68˚N, is a 10-km-scale body of basaltic magma. It formed around 55 million years ago when magma, destined to be one of the many large flood basalt flows that erupted during the opening of the Atlantic Ocean, failed to reach the surface. Instead, the magma became trapped in the crust and solidified without interruption. Surface uplift associated with the Iceland plume (the cause of the huge amounts of mantle melting, and perhaps the underlying trigger for the opening of the North Atlantic Ocean) means that the Skaergaard Intrusion is today exposed at the surface. The excellent exposure of this example of extreme basaltic fractionation makes it one of the best places in the world to study crystallisation processes. This natural laboratory was discovered by Lawrence Wager in 1930 during an expedition aimed at mapping out an air route across Greenland. Since then, studies of Skaergaard have helped progress many fundamental ideas in igneous petrology.

Mapping melt

I was part of a team of six geologists, who spent four weeks exploring the intrusion and collecting data for a range of scientific projects. The other team members comprised Sam Weatherley from the Geological Survey of Denmark and Greenland, Jens Andersen from the University of Exeter, Marian Holness and Gautier Nicoli from the University of Cambridge, and Brendan Dyck, formerly at Cambridge and now at Simon Fraser University, Canada.

We went out to Skaergaard with a large number of scientific aims that we were hoping to address. My main aim was to map late-stage melt structures across the intrusion and document field-scale evidence of differential migration of immiscible liquids. The month-long field trip was extremely conducive to group reflection and discussion. It meant that hypotheses developed at the outcrop could be discussed and refined in the evenings, with the opportunity to return and test those ideas the next day. ▶

Half the team looking out over Uttental Sund and the Skaergaard intrusion; from left to right: Sam Weatherley, Victoria Honour, Brendan Dyck. (Photo credit: Gautier Nicoli)

Relaxing on our boat journey northwards along the east Greenlandic coastline

Careful observations

My primary focus was making careful observations of the geometry of late-stage liquid segregations, to deduce the permeability of the crystal mush and to see if there were any patterns in this behaviour. With a combination of detailed mapping, small-scale observations and photography, I built a comprehensive field data-set of different features that we could link with the architecture of the solidifying crystal mush.

We looked at beautiful 'Christmas tree' dendritic structures that formed by the squirting of liquid along strongly foliated layers in an otherwise impermeable mush (just like those formed in a Hele-Shaw cell) and contrasted these with blobby pegmatitic bodies that form in unlayered and highly permeable mush. We also found many examples of pod-like accumulations of liquid in which the iron-rich and silica-rich conjugates had separated to form stark black and white divisions. Sampling was sometimes challenging because the crystals in the coarse-grained pegmatites crumbled easily, but with a lot of perseverance I collected enough samples suitable for thin sectioning (albeit still requiring a lot of epoxy impregnation!).

The expedition

Getting to East Greenland is surprisingly easy…with commercial flights from London Heathrow to Iceland and then on to Kulusuk airport in Greenland. From Kulusuk we charted a local boat, which took us 150 km north to Skaergaard and gave us a chance to acclimatise to the Arctic. We sailed past an abandoned World War II US coastal airstrip, complete with hundreds of disintegrating, rusty oil drums, and a humpback whale sunbathing just offshore. We also had to spend considerable time navigating through large areas of densely packed sea-ice. We reached Skaergaard in glorious sunshine, getting our first look at Wager's Peak, which dominates the skyline.

Fieldwork in such an environment is always a delicate balance between 'science time' and 'camp time'. The first couple of days saw us settle into our daily routine and adjust to about 19 hours of daylight. We got used to our daily commute in the field: a boat ride wearing lurid orange

survival suits, followed by a hike across the intrusion. The Arctic scenery is stunning, but it is a harsh, unforgiving landscape. There is minimal vegetation giving near 100% rock exposure—excellent for geology, but providing a colour palette restricted to whites, browns and greys, from the snow, rock and sea. That is, until our penultimate night when the Northern Lights finally put on a colourful display.

Skaergaard has a favourable micro-climate, attracting an abundance of narwhals and seals. Our fieldwork was largely uninterrupted by the local wildlife, although on one memorable morning we spotted a magnificent polar bear swimming in the fjord. We were paid regular visits by two rather poorly-behaved Arctic foxes who had a habit of chewing through socks; they relished ropes too — particularly those holding up tents and anchoring the boats. We were also paid some interesting visits by local hunters, Swiss tourists on a sailing trip, and a group of marine biologists tagging narwhals.

Working and living as part of a small team is an intense, but incredibly rewarding experience. Our departure from Greenland in the beautiful sunshine was bittersweet. While running water, fresh food and a bed beckoned, the magical wilderness of Greenland is hard to walk away from. It is a truly spectacular environment and it was a privilege to have visited and worked in such a special place. I owe many thanks to the Annie Greenly Fund from the Geological Society of London for supporting me and enabling me to join such a wonderful expedition. ◆

Victoria Honour is in the Department of Earth Sciences, University of Cambridge, UK, and was a 2017 recipient of the Geological Society of London's Annie Greenly Fund (email: vch28@cam.ac.uk; twitter: @victoria_honour).

An arctic fox sneaking around our camp in the evening

Taking measurements on the trough bands of the Skaergaard intrusion

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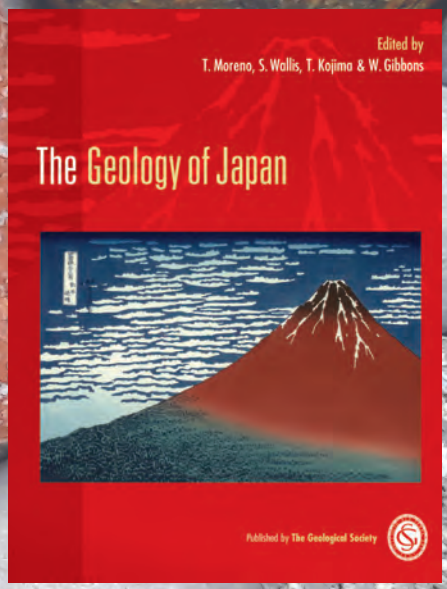

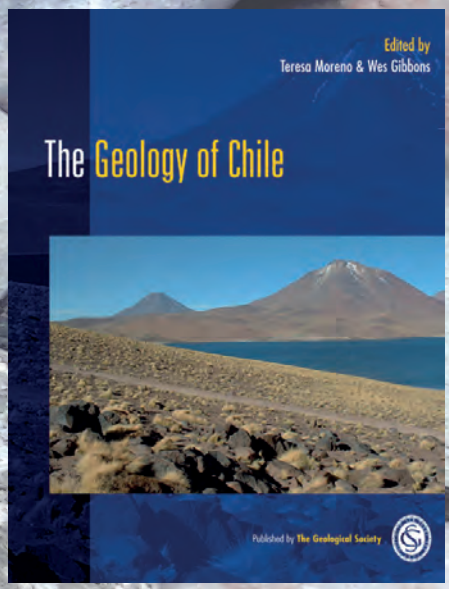

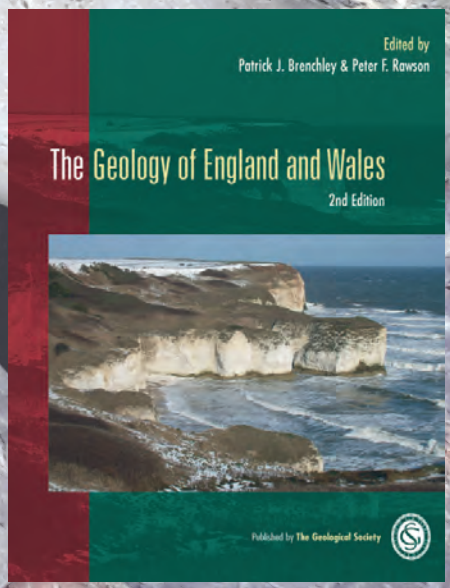

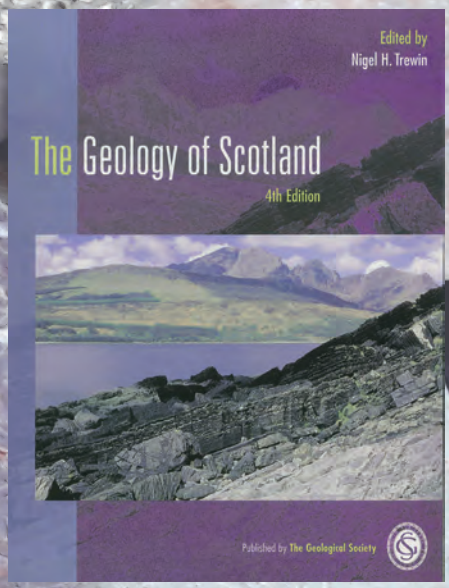

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MEETING	DATE	VENUE AND DETAILS
Lapworth's Logs	n/a	Training. 'Lapworth's Logs' is a series of e-courses involving practical exercises of increasing complexity. **Contact:** Michael de Freitas or Andrew Thompson (First Steps Ltd) **E:** office@firststeps-geo.co.uk (mention Lapworth's Logs as the subject)

EVENTS

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

MEETING	DATE	VENUE AND DETAILS
Communicating Geoscience: Building Public Interest and Promoting Inclusive Dialogue	4 Sept	**Venue:** Burlington House **Contact:** Sarah Woodcock **E:** sarah.woodcock@geolsoc.org.uk **W:** www.geolsoc.org.uk/PG-Communicating-Geoscience
Extractive Industry Geology 2018 conference	12-15 Sept	**Venue:** Calman Learning Centre, Durham University, Durham **W:** www.eigconferences.com
Joint Meeting of HOGG and GCG: Collectors, Collections and the geology of South West Britain	18-19 Sept	**Venue:** Bath Royal Literary and Scientific Institution, Bath **Contact:** Matthew Parkes or Nina Morgan **E:** mparkes@museum.ie or nina.morgan@cooptel.net **W:** www.geocurator.org
New Frontiers in Palaeogeography and Biogeography	21 Sept	**Venue:** Burlington House **Contact:** Georgina Worrall **E:** georgina.worrall@geolsoc.org.uk **W:** www.geolsoc.org.uk/palaeogeography18
8th International Conference on Environmental Chemistry and Engineering	20-22 Sept	**Venue:** Berlin, Germany **Contact:** John Dixon **E:** environmental@chemistry-conference.org **W:** environmentalchemistry.conferenceseries.com/
Engineering Group Field Meeting 2018	7-9 Sept	Field trip **Venue:** Vale of York and Ripon **Contact:** Georgina Worrall **E:** georgina.worrall@geolsoc.org.uk **W:** bit.ly/2K8d4OT

The ethics of investment

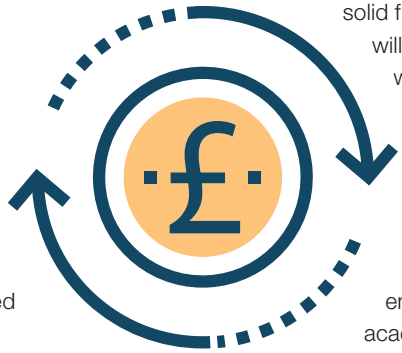
The City of London Geoscience Forum recently discussed ethical issues surrounding investment in the extractive industries. Mark Steeves* discovered that the debate is not clear-cut

Ethical investment is something of a hot topic. Alternatively known as socially responsible or sustainable investment, the idea is that financial investments should also bring about positive change, socially or environmentally. On 31 May 2018, the City of London Geoscience Forum—a group that aims to reach out and build bridges with City professionals and corporate sponsors of the Society—held a debate entitled 'Investing in the Extractive Industries'. The second of the group's series on 'Ethics in the Extractive Industries', the discussions emphasised that to achieve a certain standard of living for all people globally, we should perhaps consider it unethical not to invest in the extractive industries. But, there was a sting in the tail, a valuable reality check for the assembled audience of mining and oil industry executives, lawyers, investors and bankers: there are severe environmental and societal consequences associated with the extractive industries and investors need to be more knowledgeable in this regard.

Hosted by law firm, NortonRose Fulbright, in their London offices, the event was ably chaired by Colin Melvin (see speaker details, online). Colin's principal message was to suggest there is a distinction between sustainable investment and ethical investment—the former is an objective measure, the latter more subjective. He also referred to BlackRock chairman Larry Fink's 2018 letter to CEOs that challenged companies on their role in the community; their impact on the environment; adapting to technological change; and adjusting to an increasingly automated world.

Common good

Adam Matthews spoke first, for the Church of England (CoE), which has over £12 billion of assets under management. Despite some recent misleading headlines in national newspapers, the CoE is committed long-term to the extractive industries and understands their economic, developmental and social significance. Whilst the CoE have disinvested on climate grounds from companies that generate more than 10% of their revenue from tar sands and thermal coal, the CoE's concerns are to do with the common good. Fundamentally, Adam stated it was about responsibility: "The moment ground is broken, responsibility flows through the company, government and investors to ensure best practice and that royalties benefit wider society—the common good". Adam talked of human rights, the environment, health, safety and governance, citing Samarco's 2015 Bento Rodrigues dam disaster in Brazil and the 2012 South African Marikana massacres. Adam told us that minority shareholders and co-venture partners have "nowhere to hide" and are as subject to scrutiny as major listed multinational mining and oil companies.



David Nussbaum, CEO of The Elders, with a nod to our hosts—lawyers—said that "being legal is not the same as being ethical": ethics imply constraints beyond the minimum required by law. Extracted products are not socially useless and have value to humanity, but David has been in the business of holding companies and governments to account for many years and is concerned about the process of extraction, bribery and the environment. Extractive industries have aggravated inequality and exclusion in many societies around the world and David asserted that the expectations of the people of the world are increasing. Nobody can argue with that last point.

Complex challenges

It fell to retired long-term Shell and Exxon executive Glen Cayley to defend the petroleum industry, which he did, determinedly and robustly. Glen acknowledged the complex challenges faced by society, but he also drew attention to the 1-in-3 people around the world with no access to electricity, the 1.2 billion people awaiting their first light bulb, the 3 billion people who cook over solid fuel fires: these people will not be amongst those who question ambitions for economic growth and a determination to improve quality of life. Glen acknowledged climate change. He suggested that enlightened governments, academia, industry and the most gifted entrepreneurs will tackle the threats to our world without crushing the prospects for the poorest. Glen exhorted us to inspire future engineers and scientists to innovate and invent, to meet the world's challenges. He concluded by asking "Is it ethical *not* to invest?"

Mike Harris, our last speaker, provided the reality check. He has had a life time working in the mining industry, retiring from Rio Tinto in January 2018. Now a Visiting Professor in the Department of Earth Science & Engineering at Imperial College London, Mike delivers lectures on 'The Morality of Mining'. Some of the audience will have known what to expect. I didn't.

Mike recited a ream of government and agency policy statements, industry statistics and estimates about many minerals and ores, but for me, those around copper were a revelation and most illustrative. According to the International Energy Agency, the number of electric vehicles worldwide is set to triple by 2020 to 13 million, and these vehicles use approximately 4 times more copper than conventional combustion engine vehicles. It is estimated that every new megawatt of wind power will require around 3.6 tonnes of copper and each new megawatt of photovoltaic solar power another 4 to 5 tonnes of copper.

Yet, there is only one copper mine in the world that produces 1 million tonnes per year. About 200 of the currently producing copper mines are forecast to reach the end of their productive lives by 2035 and less than half a dozen large new copper mines have been discovered in the last 25 years. Mike had a similar tale to tell about iron ore, lithium, cobalt, nickel and so on.

Big questions

Mike asked some big questions: are we comfortable with our assumptions on who owns natural resources—is it local government, the people who live there, the people of that country, or have those resources become global resources? Who should benefit from mining those resources, and who has the moral right to restrict the availability of commodities to the vast numbers of people going from a rural to an urban environment? We were reminded of some basic science and the true costs and risks of our actions: for instance, at Rio Tinto, the operational total CO_2 equivalent emissions are around 30 million tonnes per year, which does not include the more than 520 million tonnes of CO_2 equivalent emitted by customers using its iron ore to make steel. Is steel in the headlines? No, except in terms of the social cost of losing jobs.

Where will the new materials come from to supply the renewable technologies and infrastructure, and to supply those people aspiring to lifestyles more akin to our own? The practical answer to this increase in demand will be to mine ever lower grade ores in ever larger mines, with the consequent environmental issues, and to increase prices.

I wondered about the social consequences: is the price we pay a sufficiently good one to allow developing nations to enjoy the same benefits we in the West already derive from 'their' commodities? And if it is, can the governments of developing countries be trusted to manage the wealth responsibly, productively and for the benefit of all their people? Evidently, to judge from the migrant flows from African and other resource-rich countries, the answer is another emphatic no.

As a Friend of the Geological Society and not a geologist, I ask myself whether geoscientists should more determinedly put themselves forward as responsible guardians of Earth's riches, not only to counter their social media reputation as plundering and exploitative extractors of resources for their own personal enrichment, but because they know what they're talking about! With their experience of extracting Earth's resources and having an evidence-based idea of the quanta involved, and with their deep understanding of climate change over millennia and their ability to project what this might mean in the future, geoscientists are in a strong position to inform the ill-informed, counter extreme views and advise government policy. The Geological Society is—should be—their platform to do so.

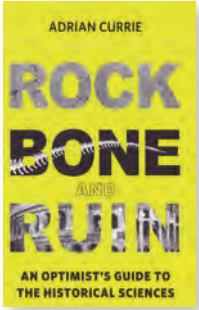
Mark Steeves, Samphire & Associates Ltd, sits on the City of London Geoscience Forum and Corporate Affiliates Committee.
E-mail: MS@SamphireAssociates.com

FURTHER READING

An extended list of selected references may be read in the online version of this article. *Editor.*

www.blackrock.com/corporate/investor-relations/larry-fink-ceo-letter

Rock, Bone, and Ruin: An optimist's guide to the historical sciences



The historical sciences of geology, palaeontology and archaeology are now wonderfully presented on TV. The stories are confidently told—but how much, and how strong, is the evidence for trustworthy interpretations?

Adrian Currie, a philosopher, believes that the historical sciences have been neglected by philosophers. Currie emphasises that although the species or landscapes are now extinct, there is evidence from this unobservable deep past for their reconstruction and understanding. This evidence, the records of a rock, bone, tooth, fossilised footprint or perhaps coprolite, are very meagre, gappy, often degraded or decayed and maybe conflicting; but such things are all we have. We make the best use of it to build theories of development, of the Earth and its life systems.

Currie gives examples of these deductions—for example, of a prehistoric duck-billed platypus and its size from just a single fossilized tooth; or of 'Snowball Earth' through the morphology of sparse glacial deposits. Some evidence is stronger than others, and Currie gives discourse on such points as how a bone might give a suggestion of animal's size, or age, or (from a jaw-bone) evidence of diet. He finds the evidence not so convincing on weight, because the weight requires knowledge of the density of the body, and from the nature of any footprints hints about the gait and general behaviour.

While reviewing 'Rock, Bone, and Ruin' I attended a lecture by David Norman entitled 'Could we ever know how dinosaurs thought or behaved?' (Geological Society of London Public Lecture Series, www.youtube.com/watch?v=KB2Q9ARMEbE). This lecture presented many lovely further examples of precisely the points that Currie discusses - of how lines of evidence and deduction, in forensic style, including our knowledge of living creatures that are distant relatives, can be used to create plausible pictures of nature in the deep and only indirectly 'observable' past.

Currie hopes that his book will have broad appeal, and that his arguments will make sense to non-philosophers. But, although absorbing, I am not sure how wide his non-philosophical readership will be. The book certainly needs a glossary to give clear definitions of his philosophical terms. The book is an intriguing read however, presenting a thought-provoking discussion of the reasoning processes and methodologies whereby sparse traces of evidence can be put together to re-create the vanished.

Reviewed by: ***Richard Dawe***

ROCK, BONE, AND RUIN: AN OPTIMIST'S GUIDE TO THE HISTORICAL SCIENCES
by ADRIAN CURRIE, 2018. Published by The MIT University Press, Cambridge, MA., 372pp. hbk. ISBN 978-0-262-03726-6. **List Price: £27.95. W: mitpress.mit.edu/contributors/adrian-currie98**

Lake Pavin History, Geology, Biogeochemistry, and Sedimentology of a Deep Meromictic Maar Lake

This volume presents a fairly comprehensive account of the geology and ecology of Lake Pavin, in the Auvergne Mountains of the French Massif Central. The lake marks the site of the region's last eruption some 7,000 years ago. Originally formed as a volcanic maar with a lake over 100 m deep, the height of the lake's only outlet was then reduced several times. Typically, lake surface waters do not mix with those at depth, which remain isolated or meromictic with some seasonal exchange – processes ably demonstrated in a chapter on the carbon cycle that includes the water balance within the lake, with deep mineral springs at depths of 53 and 68 m.

Following the 1986 Lake Nyos degassing disaster in Cameroon, when this maar-lake emitted a blanket of heavier-than-air carbon dioxide that flowed down the local valley for over 20 km killing at least 1,700 people, research into such events significantly increased. The second chapter looks into possible historical degassing events at Lake Pavin. I remain rather unconvinced, however, when evidence for the 1936 event relies on one witness fifty years later. It would have been interesting to consider the future faint possibility of crustal relaxation, followed by intrusion and near-surface degassing of magmatic dykes beneath these post glacial maars.

A brief chapter on the Monts Dore caldera sets the scene for the geological chapters. Another outlines two centuries of debate and controversy, followed by a chapter on the phreatomagmatic deposits themselves. This excellent account is blighted by poorly reproduced figures, which often appear in pallid pastel tones. Geographical coordinates, either in the margins or text, are not given for some truly innovative geophysical sections and photographs of freshly excavated faces. While the English is better than in many chapters, Fig. 6.2 with "actualized traduction" for the word translation within the caption sums up the failure of not employing native speakers to improve the text, which is often full of French syntax.

The magmatic evolution of the four southernmost Chaîne des Puys volcanoes is detailed before another chapter considers the distribution of ashes from these eruptions over the surrounding countryside. The geomorphology of the lake and surrounding area is discussed without nearly enough space for the figures. A chapter on farmed fish populations and methods for estimating catches, precedes two final chapters on sedimentology and paleolimnology. The former reproduces multi-beam bathymetry and bottom profiles alongside sampled gravity cores, while the latter uses deeper cores to reconstruct the maar when it was 13 m higher, before a catastrophic lake outburst some 1,400 years ago.

Reviewed by: ***David Nowell***

LAKE PAVIN HISTORY, GEOLOGY, BIOGEOCHEMISTRY, AND SEDIMENTOLOGY OF A DEEP MEROMICTIC MAAR LAKE
by SIME-NGANDO, T, BOIVIN, P, CHAPRON, E, JÉZÉQUEL, D & MEYBECK, M (eds) 2016. Published by Springer. 421pp. hbk. ISBN: 978-3-319-39960-7.
List Price: £149.99. W: www.springer.com

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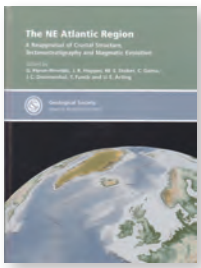
The NE Atlantic Region: A Reappraisal of Crustal Structure, Tectonostratigraphy and Magmatic Evolution



The scale, remoteness and challenging geology of the North-East Atlantic means that the majority of scientific work has been carried out in a patchwork fashion. Comparison to conjugate and adjourning margins was difficult due to the lack of a regional stratigraphic scheme and a homogenised database.

However, this is no longer the case thanks to the multinational, industry supported, Northeast Atlantic Geoscience TECtonostratigraphic Atlas (NAG-TEC) project. The project ran from 2008 to 2014, and involved 8 geological surveys and partner universities, with the aim of re-examining the evolution of the North-East Atlantic from the Devonian to the present day. The outputs of the project are available in publication by The Geological Survey of Denmark and Greenland (GEUS), but this special publication contains 17 papers that outline the more scientific aspects of the NAG-TEC project.

The area of interest ranges from the Charlie-Gibbs Fracture Zone to offshore Svalbard with a particular emphasis on conjugate margin studies and the insights that they provide for our understanding of North-East Atlantic evolution. The topics covered include stratigraphy, plate kinematics, geochronology, volcanism and crustal structure. A series of papers also cover interesting aspects that arose from the project.

The content is most relevant to those who work on the region due to a common database allowing the production of large-scale regional maps and correlation panels along and across the study area. The papers are well written but due to the nature of the project are 'review-esque' in their style with very little new data presented. Not that this detracts from their quality and usefulness. One paper that requires mention is the 57-page overview of the Upper Paleozoic-Mesozoic stratigraphy of the North-East Atlantic. The overview is one of the most comprehensive I have seen, but attempts to read it in one go are certainly not for the faint hearted!

This book will become a standard reference work for those working in the area, for the foreseeable future. So, should you buy this book? Well no, not unless you like physical printed books. Thanks to the Gold Open Access scheme, the entire publication is available to download for free from the Lyell Collection, so you can pick and choose the papers as you wish. This makes me wonder what the rationale of a printed volume is, but that is a topic for a different day.

Reviewed by: ***Gavin Elliott***

THE NE ATLANTIC REGION: A REAPPRAISAL OF CRUSTAL STRUCTURE, TECTONOSTRATIGRAPHY AND MAGMATIC EVOLUTION
By Péron-Pinvidic G, Hopper JR, Stoker MS, Gaina C, Doornenbal JC, Funck T & Árting UE (Eds) 2017. Published by: Geological Society of London SP 447, 468pp. hbk. ISBN: 978-1-78620-278-9.
List Price: £120.00. Fellow's Price: £60.00
W: www.geolsoc.org.uk/SP447

Crustal Evolution of India and Antarctica: The Supercontinent Connection

Gondwana hosts a multitude of geological secrets, and this volume delves a long way back in deep time to help unravel of some of these hidden geological complexities. Don't expect to find anything younger than the Precambrian in these pages. Indeed, the title would be enhanced by the inclusion of the word Proterozoic, so readers looking to know more about the Mesozoic disintegration of Gondwana need look no further. If your passion is geochronology and plate reconstructions of the supercontinents Columbia (~1.5 Ga) and Rodinia (~1 Ga), as well as Gondwana's early history (to ~0.5 Ga), then this is a tome you will want to access.

The book is a compilation of 13 articles distilled from about 200 papers presented at the 2015 symposium on Antarctic Science, held in Goa and hosted by the Scientific Committee on Antarctic Research (SCAR). It has only been two years in gestation, so the papers are up-to-date and topical. The Precambrian history of Earth is characterized by the 'yo-yo'-like assembly and disintegration of supercontinents, of which both Antarctica and India are important components. Lively debate continues regarding their terrain boundaries and their mutual linkages, and the integration of tectonics, petrology and geochronology is seen as the route to re-assembling the palaeotectonic jig-saw puzzle. Palaeontology isn't useful for terrain correlation in the depths of Proterozoic time, so high-resolution geochemistry and geochronology feature prominently in the researchers' tool kit.

The volume contains related papers that address some of the topical questions of where, why, and when the supercontinents assembled and broke up. The first three papers are specific to western Antarctica and address the geochronology of cratons that have affinities with eastern India, Mozambique and South Africa. Most of the remaining chapters detail aspects of the Indian mobile belts (Eastern Ghats and Aravalli-Delhi), as well as the petrology of the gneissic cratons. It would have been useful to include a comprehensive summary paper to start the volume, providing some linking elements and perhaps discussion of the key challenges in terrain reconstruction. The absence of such a paper is perhaps why I enjoyed the final misfit contribution in the volume by Joe Meet et al. on the use of palaeomagnetic data to provide an alternative view of supercontinent assembly.

This is a nicely produced volume. The compilation works well in covering a billion years in less than 400 pages. It is not a book you will browse for general information. Rather, it will stand as a staple reference for researchers working on Proterozoic terrain reconstruction for years to come.

Reviewed by: ***Stuart Burley***

CRUSTAL EVOLUTION OF INDIA AND ANTARCTICA: THE SUPERCONTINENT CONNECTION
Edited by N.C. PANT & S. DASGUTPA. Geological Society of London Special Publication No 457, 2017. 359pp. hbk. ISBN 978-1-78620-319-9.
List price: £ 120.00. Fellow's price: £ 60.00.
W: https://www.geolsoc.org.uk/SP457

DISTANT THUNDER

Soldiering on

Geologist and science writer Nina Morgan considers the advantages of a daily commute

For those of us 'wage slaves', the commute to work can seem like just another part of the daily grind. But for the geologist William Lonsdale [1794-1971] a daily commute offered an ideal opportunity for fossil hunting and a chance to advance his geological studies.

Born in Bath, at the age of 16, Lonsdale obtained a commission in 1810 as an ensign in the 4th King's Own Regiment and went on to serve in the battles of Salamanca and Waterloo. In around 1815, after his battalion was reduced, Lonsdale found himself unexpectedly placed on half-pay. So, he left the army and went to live with his mother at Batheaston, a village east of Bath.

While visiting the library in Bath, he overheard a conversation between two ladies who were discussing a fossil that had been found in the neighbourhood. For Lonsdale, geologically speaking, the rest is history. Intrigued by what he had overheard, he decided to become a geologist.

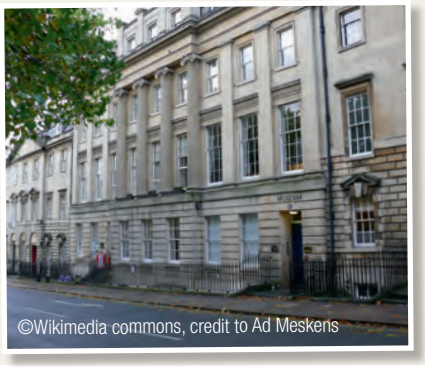
Hammer

In 1825, Roderick Murchison [1792-1871] was so impressed on meeting Lonsdale, who he described as an "all grave man, with a huge hammer on his shoulder", that he interrupted a 9-week geological tour along the south coast to "stay some days in Bath under his [Lonsdale's] guidance".

That same year, Lonsdale was appointed as the first honorary curator of the newly formed Bath Literary and Scientific Institution. He travelled daily to his new job from Batheaston on foot, a round trip of around 6 miles, and took advantage of the commute to collect fossils and study the local geology.

As W. S. Mitchell, writing about Bath Geologists in 1873 in the Proceedings of the Bath Natural History Club revealed:

"I have been told by three or four people who knew him that he used to walk in from Batheaston to the Institution quite early in the morning, when light permitted, often as early as six o'clock, and that he would steadily work the whole day through with no voluntary interruption whatever, not even for refreshment, a few biscuits while at work being all that he required till he returned to his home in the evening."



©Wikimedia commons, credit to Ad Meskens

Lonsdale turned out to be a prolific fossil collector, donating over 1,000 specimens to the Bath Museum, and, Mitchell continues, his curatorial work also received accolades:

"His catalogues of our Museum, apart from their scientific value, are well worth of inspection as probably unrivalled specimens of neat and methodical work. Of all the catalogues of different museums which I have seen I do not recollect one which could be in any way considered superior in these respects".

Headhunted

Lonsdale was elected a Fellow of the Geological Society in 1829 and, reports Mitchell, was soon lured away:

"Unfortunately for Bath, he was so well known as an energetic and painstaking curator that he was appointed curator and librarian of the Geological Society of London..."

While at the Geological Society, Lonsdale became known both for his editorial skills and his geological studies. As well as presenting papers and mapping boundaries of various formations on the new one-inch ordnance maps, he became an authority on corals. His work on the fossils of the South Devon limestones led him to suggest, in 1837, that they must be of an age intermediate between the Carboniferous and Silurian systems. This suggestion was adopted by Adam Sedgwick [1785 – 1873] and Murchison in 1839, and played an important role in the founding of the Devonian system.

Going to ground

After 13 years in London, Lonsdale resigned this post in 1842 due to ill health, and returned to continue his geological studies in the west of England—with apparently no fixed address. After his retirement, notes Mitchell:

"It was frequently impossible without great difficulty for his Geological friends to know how to communicate with him. For many years previous to his death his name appeared in the list of the Geological Society without any address attached to it, and he frequently changed his place of abode."

The last recorded 'geological' sighting of Lonsdale took place at the time of the British Association meeting held in 1864, when Murchison reported visiting Lonsdale in Bristol. Lonsdale died in Bristol in 1871, described by one of his relatives as one who "worked hard for Geology, but with us was the old soldier to the last."

Acknowledgement
Sources include: The 1911 Encyclopaedia Britannica entry for William Lonsdale by Henry Woodward; the DNB Entry for Lonsdale by Stella Whyberd Pierce; The Life of R.I. Murchison by Archibald Geikie; Notes on early geologists connected with the neighbourhood of Bath by W.W. Mitchell, *Proceedings of the Bath Natural History And Antiquarian Field Club*, 2, (1872), pp. 303-341. Lonsdale will feature in a meeting highlighting the geology of south west Britain taking place at BRLSI on 18/19 September 2018. For more information see: www.geocurator.org

* **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

Meet Nick Rogers

Nick grew up in Hertfordshire and attended a small church school, where he was indoctrinated in the bible. Home was a farm labourer's cottage with an outside chemical toilet that was, according to his brother, haunted by the Holy Spirit. Nick was the first in his family to attend university. He began his geoscience training in London, obtaining a first degree in geology with chemistry from Bedford College.

For as long as he can recall, Nick has been intrigued by what the Earth is made of, especially the deep and hidden layers. Pursuing this fascination, Nick completed a Master's in geochemistry at the University of Leeds and a Ph.D. at Imperial College, investigating the trace element contents of kimberlites and xenoliths to understand the composition and evolution of the continental mantle and lower crust.

Nick began his professional career in 1983 as a research technician at the Open University. He ran the neutron activation laboratory—apparently sparking rumours of a link between radiation exposure and hair loss—and continuing his research in trace element and isotope geochemistry. Over the next 35 years, Nick gradually climbed the promotion ladder, going on to become the Head of Department, Associate Dean and Science Programme Director in the Science Faculty. Nick supervised over 20 Ph.D. students and published more than 100 peer-reviewed papers. He somehow also managed to find time to edit The Journal of the Geological Society, serve on Council as Publications Secretary and Chair of the Education Committee, and latterly to be a regular member of the NERC grant-review panel. Now an emeritus professor, Nick caps off a successful career with his presidency.

Service

Nick talked warmly of the important role the Geological Society plays in supporting geoscientists throughout their career: "I have always found that my activity with the Society has complemented my career at the OU, giving me the experience and confidence to apply for more responsible roles in my day job.

"I take the Society's strap line of 'service to science, profession and society' seriously, with the emphasis on service. I used to recoil from that word, but as my career has developed I now see that it is only by serving organisations—sometimes as a leader, as a team member or just an individual—that I reap any satisfaction from professional activity."

We touched on the Society's ten-year strategy and its emphasis on scientific excellence, integrity and equality, as well as social and environmental sustainability and responsibility. "My aim is to lead the Society in line with those values, which are close to my own. I have no particular or personal agenda, but I would like to see the Society improve its relationship with the academic community. We already serve that sector through scientific meetings and publications but can improve in areas of degree accreditation and facilitating links with industry. There is a multiplicity of paths from school through university and on to professional life, and a key role of the Society is to facilitate that journey for each and every geologist. The Society is uniquely positioned to connect education, research, industry and policy, and with the increasing emphasis on skills in higher education that role is more important than ever."

Future

One issue that looms over the Society is the uncertainty surrounding the lease of Burlington House. Nick would love to secure the lease during his presidency, but given the two-year time constraint of the role, it's probably more realistic to aim for keeping the lease on track, with the intention of securing it within the next few years: "A common criticism of the Society is the level of fellowship fees and the maintenance of the building is sometimes unfairly cited as a reason for those fees. The society undertakes a multiplicity of activities that are required by the charities commission to be financially sustainable and the fees are carefully set at a level to ensure that outcome. Consequently, we need to be able to secure our tenancy of Burlington House on favourable terms to avoid the financial burden of excessive rent increases or, even worse, the operational disruption of being forced to move out."

Nick is keen to see how the dynamic of the Society changes in the coming years, given the recent influx of new senior staff. Acknowledging the major achievements of outgoing staff members, he said that "new colleagues bring in fresh ideas and will take the Society in new and interesting directions". The increase in diversity at senior levels is important, but Nick stressed that the primary focus will always be on excellent science, which is exemplified with the thematic years—currently 'resources' and 'carbon' for 2019.

I was chiefly struck by the gratitude Nick expressed—he feels indebted to the many institutions that have supported him, and in particular to the Open University for the training and resources they provided. He emphasised how important it to remember the communities and institutions that sustain us through our careers. Nick has a strong desire to give back to the geoscience community and feels his presidency is a chance to pay back an organisation that has served him well and whose values he shares.

Read the full interview Online. *Editor*

Essential tips for a rock-solid geoscience PhD: Part I

Thinking of doing a PhD? In the first of a three-part focus, Melanie Leng & Anson Mackay explain how to get started on the right foot

Embarking on a PhD is a big decision. It will consume 3 to 4 years of your life, so why do it? Well, maybe because you want to learn more about the world and wish to challenge yourself? Maybe you want to develop as a person and improve your abilities to understand and solve problems? Or maybe you want to become a better communicator, to be able to engage with a wide audience of both experts and non-experts alike. Doing a PhD should increase your confidence and time management. Plus, if you have a lifelong fascination with something in geoscience then you should be able to tailor a doctorate to suit your particular interests. Your PhD could set your future employment opportunities and influence the rest of your life. There's a lot to consider when choosing a PhD, from the discipline and project to pursue, to the university you study at.

Together, we've supervised over 100 geoscience PhD students through to graduation. Our advice is not exhaustive, but it comes from decades of personal experiences as PhD supervisors, as well as from published and on-line observations. There is no doubt that doing a PhD can be a stressful process, and thankfully universities are beginning to acknowledge the scale of the problem. So, take your time choosing a PhD—it's a big decision! Think in advance about your own expectations and those of the supervisor. There are many things to consider, but hopefully some of the advice below will make the experience a more enjoyable one.

Choose your supervisor

It may be a killer project, but it's important to know who your supervisors are. After securing an interview or meeting, do some research. Look up the potential supervisor(s) and their laboratory or research group via their websites, and online presence. Do they appear interesting and are they doing research that genuinely interests you? Look at how many other PhD students and postdocs there are, and take time to consider the diversity of the research group. Do they look like a dynamic and diverse research group that you would want to feel part of? You may wish to contact current and former PhD students of that supervisor to get a feel for their experiences in the group. You may also want to find out if any staff member in your undergraduate school is in the same field. If so, ask if they know anything about the research group you may be joining (but be mindful, all relationships are different and they might see themselves as competitors).

Which research group does the potential supervisor sit in within the School? Is it relevant to the project? Are there others in the School doing similar research? These may seem like minor issues, but being part of an internal research team can lead to a much richer experience.

If you get an interview, prepare some questions before hand. Ask about the project, the postgraduate environment in the School, how often supervisory meetings will be held, what training and teaching experience will be offered, what the work-life balance culture is like.

You have to spend 3 to 4 years working closely with your supervisors, so make sure you can.

Student-supervisor relationships

In the UK, geoscience PhD students typically have 2 supervisors, but you may also have several more (external/unofficial/collaborators) to cover the many different facets of your research. The first supervisor is usually key and will do most of the supervision and administration.

Ensure you have regular official meetings, at least every few weeks in the early stages. Most universities in the UK require documented meetings every month or so, and it is your responsibility to arrange these. Many universities now have electronic log books where meetings can be written up and signed off on-line. Try to get your second supervisor to attend, too. Create an agenda before the meeting, write notes in the meeting and type these up as minutes with actions (and agreed deadlines). E-mail the minutes around soon after the meetings. If relevant, upload these into an electronic log. Make sure your (evolving) career goals are regularly discussed with your supervisors.

Doing a PhD can be stressful, and personal support is needed, but keep these supervisory meetings efficient and productive, focussed on the project, especially if more than one advisor is present. Arrange separate meetings to discuss any personal issues relevant to progress of the PhD (these could also be with your second supervisor or postgraduate tutor). Ideally such meetings should take place before the main meeting, so that any progress and action points discussed are done so with the previous discussions in mind. Informal meetings over coffee are also beneficial.

Your supervisors are not your friends (although your relationship may develop into a close friendship, post PhD). It's probably not a good idea to "Friend" your supervisor on Facebook (or vice versa), at least until you have finished your PhD.

If at any time in your PhD you feel that the relationship with your supervisor is deteriorating, seek advice immediately from your departmental graduate tutor. All universities have clear harassment and bullying policies, often called dignity at work statements, which your departmental graduate tutor will be aware of. Harassment and bullying can take many forms, and knowing how these can manifest is important.

Keeping in touch

If you don't have the opportunity to see your supervisors for a few weeks, then send an

e-mail update. A few sentences are fine, and if you want to cover more than one topic then number the topics. As you become more independent contact time may decrease.

If you e-mail correspond with other supervisors/collaborators, it's a good idea to CC (Carbon Copy) your main supervisor too—a CC link usually means that they don't have to respond. If emailing a large number of people, use the BCC (Blind Carbon Copy) feature. Individual e-mail addresses are then invisible to recipients, preventing unwanted emails that can result from the "Reply to All" feature.

Work-life balance

Most academics consider their work as a vocation. There is a culture of working long hours, although this should not be expected. Be mindful of tight spots in the academic year—periods of exams, marking, heavy teaching weeks, application deadlines. Don't be put off by this culture; you can succeed working 9-5, 5 days a week, but you will need to be flexible when deadlines loom. Many geoscience PhD projects involve fieldwork, which involve longer hours. Bear in mind that coffee/tea breaks are useful for building relationship, as well as discussing approaches and ideas. Time away from your desk can be enlightening. Have regular breaks, but keep them to a schedule.

Taking work home should not be the norm, but deadlines may require it. Sometimes taking a difficult paper or data set home to look at in the quiet and comfort of your sofa can be revelational. Try to be efficient, aim to achieve something every day, even if the accomplishment is small (and write these down to discuss at your supervisory meetings).

Have a life outside of your PhD. Get out at weekends, spend time with your friends and family, participate in a sport or hobby. People who only work, potentially either burn out or are more likely to develop mental health issues.

The mental health of PhD students is precarious: postgraduate students are up to six times more likely to experience depression and anxiety compared to the general population. Your mental (and physical) health is extremely important. Universities offer welfare services, well-being clinics and stress management courses, and you can also seek help through your GP (remember to register with your local practise). It is important to get plenty of sleep, learn how to shut off in the evenings and weekends.

Remember, there are those around you who are going/have gone through similar experiences. Peer support is a vital (although not often spoken about) form of support while doing a PhD, so try and put into place a good support network. Attend School social events, especially those organised for PhD students. And talk to your supervisors, they may be more understanding than you think.

Look out for parts II and III, which include advice on data management, giving presentations, writing up your thesis and planning for your career beyond the PhD, in the October and November issues of Geoscientist.

"POSTGRADUATE STUDENTS ARE UP TO SIX TIMES MORE LIKELY TO EXPERIENCE DEPRESSION AND ANXIETY COMPARED TO THE GENERAL POPULATION. YOUR MENTAL (AND PHYSICAL) HEALTH IS EXTREMELY IMPORTANT

Melanie Leng[1] is Director of Geochemistry at the British Geological Survey, UK, and Professor in Isotope Geoscience at the University of Nottingham, UK.

Anson Mackay[2] is Professor in Environmental Change at UCL, UK, and an Honorary Research Associate at the British Geological Survey.

[1]mjl@bgs.ac.uk

[2]ans.mackay@ucl.ac.uk

OBITUARY Nigel Trewin 1944-2017

'Geology of Scotland' editor, renowned Old Red Sandstone expert, lecturer and dear friend to many, inspired generations of geologists. He will be sorely missed

Nigel began collecting fossils at the age of 10, which sparked a passion for everything geology. He went on to receive his Ph.D. from Keele University and became a demonstrator there until 1968, before moving to Aberdeen. During his 40 years at Aberdeen University, Nigel rose to Personal Chair in 2004 and was instrumental in making the campus one of the top places to study geology in the world.

Scottish Geology

With over 100 publications on Scottish geology relating to Old Red Sandstone (ORS) fish beds, sedimentology and palaeoecology, his contribution to the science is immeasurable.

Along with Dr Clive Rice, Nigel spent over 15 years dedicated to examining the rare plant, fungal and animal fossils found in the ~410 million-year-old Rhynie Chert unit in Aberdeenshire, Scotland.

In 2005 Nigel received the Clough Medal of Edinburgh Geology Society for research on Scottish Geology, and in 2009 accepted the T N George Medal of Glasgow Geology Society for 'Excellence in Palaeontology'. Nigel was also a founding member of the Aberdeen Geological Society.

Nigel will be remembered by his students as the witty geology professor who delivered each lecture with humour and an unbroken smile, giving his nick name as 'The Joker'. One of his most memorable lectures was discussing geology and whisky where he concluded that all Scottish whisky is from water sourced either from sandstone or granite with one anomaly. The anomalous whisky had its source waters run over the Old Red Sandstone Fish Beds and was also his favourite, believing it contained the ghosts of these ancient sea creatures.

Collector

Professor Trewin, who was often referred to as a modern 'Victorian Naturalist', had a broad range of interests and, in keeping with this image, was a keen collector of many odd things. One of his finest collections was of Postal History of Aberdeen and Aberdeenshire where he often published his finds in the 'Scottish Post'. He also built up a fine collection of Scottish 18th Century Trade Tokens and coins, as well as old geological maps and at one time he owned a copy of William Smith's great map. His life's collection of fossils is now in care of the National Museum of Scotland.

Hugh Miller

Nigel had a great affinity with Hugh Miller and built a sizable collection of books, letters and ephemera, which he kindly donated to The Hugh Miller Museum in Cromarty. Nigel served as a Trustee and Chairman of 'The Friends of Hugh Miller' until 2016. A recent geological conference organised by the charity named 'The Old Red' celebrated the work of Miller and in part, the work conducted by Nigel and his trusted 'fish filleters' who gathered from around the world in the small Scottish village.

Nigel and wife Margaret Trewin celebrated their Golden Wedding Anniversary in 2017.

By Gavin Berkenheger

The Society notes with sadness the passing of:

Barnes, Simon James *
Booth, Tony *
Bowen, Geoffrey Gordon *
Casey, Raymond *
Fletcher, Brian *
Gladwell, David Robert *
Ince, David Martyn *
Kenna, Raymond *
Llewellyn, Peter L
Lynch, Edward *
Matheson, William *
Milward, Anthony Frederick *
Morgans, Michael William *§
Pegg, Eric Arnold *
Roberts, Brinley
Smith, Howard James *
Thomson, Martyn Hugh *

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

If you would like to contribute an obituary, please email amy.whitchurch@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.

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

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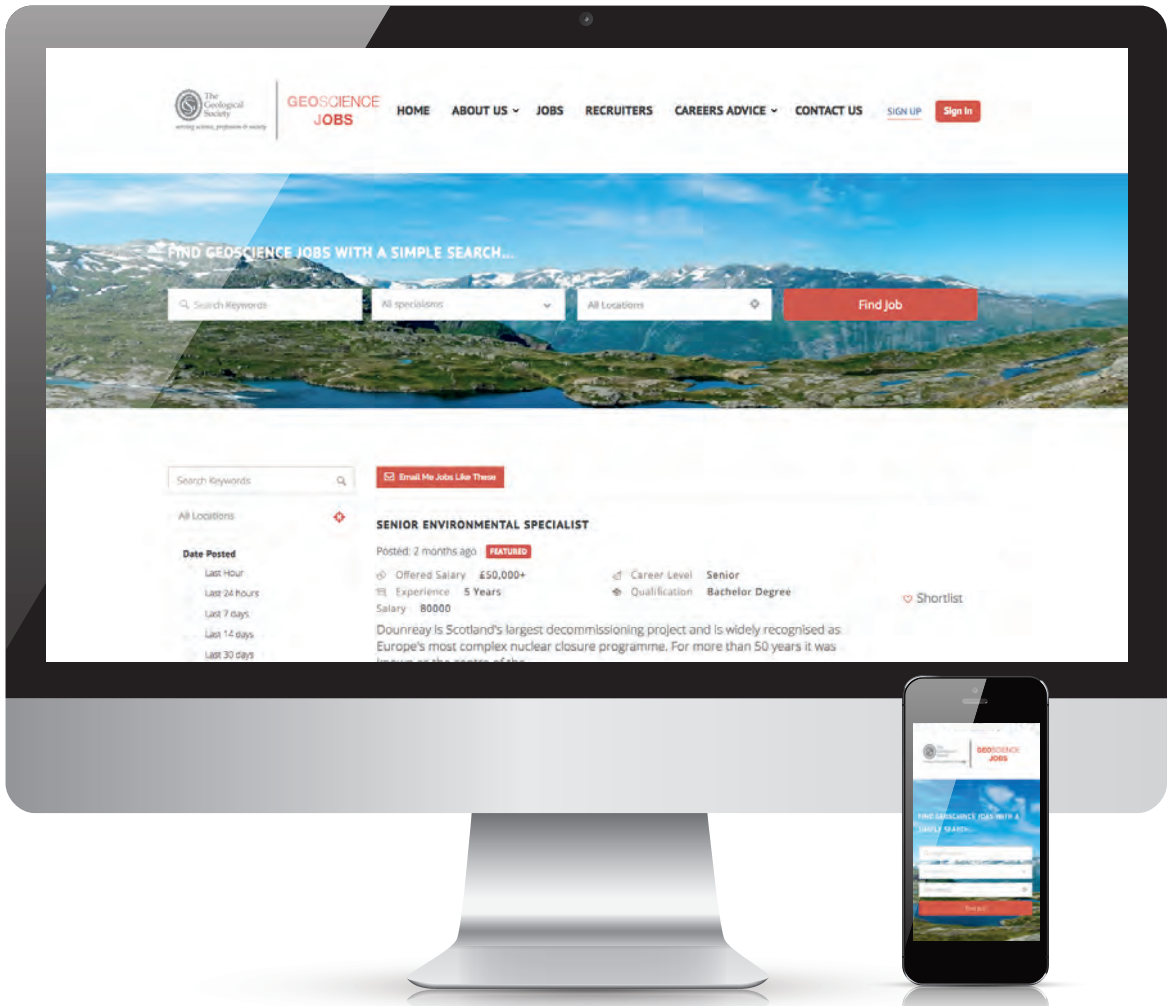

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