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The Fellowship Magazine of the Geological Society of London

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[REVIEWS SPECIAL COMING NEXT MONTH!]

Steps & cycles

Interaction of steady trend & natural cyclicity produces 'stepped' global warming

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Session 2: New Kitchens : Geodynamics and Heat Flow Modelling
Session Chairs : Helen Doran (Ophir), Julian Moore (BP)

Session 3: New Insights on Trap Types and Reservoir Geometries
Session Chairs; Jerry Jarvis (Tullow), Vincent Mashaba (Sasol)

Session 4: New Reservoirs: African Carbonates in Time and Space
Session Chairs : Fabio Lottaroli, (ENI), Ian Poyntz (HGS)

Interactive Session: Seismic Workshop
Session Chair : Patrick Coole (PGS)

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IN THIS ISSUE...

ON THE COVER:

10 Steps and cycles

Is stepwise climate change a reality or an illusion? Or could it be a natural function of steady trend and cyclicity?

ONLINE SPECIALS

Ted Nield reviews the film **San Andreas** starring **Dwayne 'The Rock' Johnson and Paul Giamatti as 'Professor Lawrence Hayes'** of CalTech, who has perfected a method of predicting earthquakes. (UK Release May 21)

FEATURES

REGULARS

Geoscientist is the Fellowship magazine of the Geological Society of London

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> INTERACTION BETWEEN SECULAR CHANGE AND CYCLIC PROCESSES COULD EXPLAIN OBSERVED 'STEPWISE' CLIMATE CHANGE, SAYS ANDY CHADWICK

COVER: Jan Martin Will/Shutterstock.com

FROM THE EDITOR'S DESK:

Leading the blind

Historically, academic publishing has always had one aspect of its operations back-to-front, and that is the matter of who, in the reviewing process, should be anonymous.

It seems double-blindingly obvious to me that, as a matter of principle, if anyone has to be anonymous, it is those who are being judged who should be protected, and not those passing judgement. This is why orchestral auditions place a performer behind a screen so that what they look like doesn't render their judges selectively deaf. Peer review, however, has traditionally been organised the other way about. Reviewers know exactly who they are judging, yet many journals still allow them to criticise from behind a discreet veil.

Internet trolling serves as a graphic reminder of what happens when people write un-attributably. It is (or should be) a principle that, except where extenuating circumstances apply (such as whistle-blowing, where the weak need protection) nobody – certainly nobody in a position of influence - should ever be permitted to write anything that they are not prepared to defend before those about whom they write. The wages of such secrecy are corruption and self-interest.

It is possible that people are basically good; but given the chance to get away with it, they are unlikely to be basically honest. Several of the papers I eventually published, long ago, suffered vexatious delay and sometimes needless rejection because one specialist editor proved to have a vested interest in maintaining priority, or suppressing falsification. I quickly learned to subvert this by an emasculating 'acknowledgement', which shows that their Harry Potter cloak didn't even work; but the fact that they thought they were invisible, made the process paltry, unedifying and disenchanting.

Writing and reviewing should never provide sanctuary for the cowardly and passive-aggressive, whether they are powerful or not. But reviewing should certainly not place stronger weapons in the hands of those who already hold them all. For this reason I have, since first writing about this in the 1980s, advocated 'double-blind' reviewing - anonymity for authors. Although poo-pooed at the time in *New Scientist*'s correspondence columns, double-blind reviewing has since achieved a 76% approval rating1,2 from surveyed scientists. The leading UK science journal *Nature* now offers double-blind reviewing.

Nature Geoscience and *Nature Climate Change*, who have allowed it since mid-2013, found take-up 'lower than enthusiasm in surveys suggested' (about 20%). But this is no discouragement. Change, even for the better, takes time.

Meanwhile I look forward to your reviews, marked 'for publication'.

* **References** *1,2:* **Mulligan A, Hall L & Raphael E,** *2013 J Am Soc Inf Sci Technol 64, 132-161; Announcement, Nature 518 19 February 2015 p 274.*

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

SOCIETY*NEWS*

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

'Geologica Britannica'

Etna Beneath our Feet, Mt Etna (Malcolm Nugent)

Glacier at Monte Rosa Massif, Zermatt, Switzerland (Peter Twigg)

Commended - Scotland - Jon Amos

Dan Welch (Chair, West Midlands Regional Group) describes the 3rd Annual Geological Photographic Competition.

Geoscientists understand the value of diagrams, conceptual models and photographs to describe complex environments to each other and to the public. Visual evidence remains a key part of fieldwork – from the most basic ground investigation to cutting edge research, particularly for *in situ* features that cannot be taken away for later study.

With this in mind, the competition was first launched in 2013 by the West Midlands Regional Group for West Midlands-based Fellows and Black Country Geological Society members only. Images by Peter Twigg, John Schroder and Jon Amos took awards.

In January 2014 the competition was thrown open to include any local geologists, amateur or professional, working or retired in not just the West Midlands and Black Country Region but in the Southern Wales Region too. Provided you lived in either, you could enter. The theme: 'What Lies Beneath our Feet'.

Nearly one hundred entries were received, representing famous geological locations from Nambia to Iceland and Bude to Torquay. Judges (Jon Clatworthy (Lapworth Museum), Bill Gaskarth (Geological Society of London) and Adrian Durkin (Dudley Museum & Art Gallery)) gathered at the Lapworth Museum, University of Birmingham and deliberated over the images. Malcolm Nugent's 'Etna Beneath Our Feet' was awarded First Prize, taking away £200

Themed years are at the heart of the Society's Science Strategy, and this year the Society celebrates both the 'Year of Mud' and the bicentenary of William Smith's famous geological map. With these in mind, the West Midlands, Southern Wales and North West Regional Groups of the Society and Black Country Geological Society are joining, with sponsorship provided by Geotechnical Engineering Ltd., to bring you the 3rd annual photographic competition on the theme of… 'Geologica Britannica - Exhibiting the Geology of the British Isles and Applied Geology in the British Isles'.

INFORMATION FOR ENTRANTS

Full details of the rules can be found at www.geolsoc.org.uk/JointPhotoComp - images will be selected by a panel of independent Judges and there will be 10 winners

Name	Expertise
1st Prize	£200 Sponsored by Geotechnical Engineering Limited, plus £150 special publication gift voucher donated by Geological Society Publishing House, plus William Smith Map Reproduction and Memoir
2nd Prize	£150 Sponsored by Geotechnical Engineering Limited plus Geological Map of Great Britain, Bicentennial edition
3rd Prize	£100 Sponsored by Geotechnical Engineering Limited plus Geological Map of Great Britain, Bicentennial edition
4th and 5th Prizes	Geological Map of Great Britain, Bicentennial edition
6th to 10th Prize:	Geological Hammer USB Drive, donated by Geological Society London

You have until midnight Tuesday 1 December. Submit your images to jointPhotoComp@geolsoc.org.uk. For detailed rules, terms and conditions please visit www.geolsoc.org.uk/JointPhotoComp. @wmids_geolsoc #GeologicaBritannic #JointPhotoComp.

25 years of CGeol

Edmund Nickless, Executive Secretary, on the first quarter century of Chartership.

In 1972, the Council of the Geological Society set in train a series of events that saw the formation of the Institution of Geologists and ultimately, the creation of the Chartered Geologist title. The development of the Society to encompass regulation of the geological profession was made possible almost two decades later when in 1990, the membership of the Institution of Geologists decided by a large majority to accept an invitation from the then President to join the Geological Society.

The process of change started by the absorption of members of the former Institution of Geologists has seen a fundamental restructuring of the Society with continuing evolution during the succeeding decades to meet the changing needs of the geological sciences, the geological profession and society at large.

Looking back, it is always difficult to judge actions then by the standards of today and 25 years is not all that long. In seeking to advance professionalism within the geosciences there were concerns to widen access and to achieve a better level of gender equality. We have made

IG Jewel

some progress. In 2001 15.5% of the Fellowship was female; a decade later that was 19.5%. In 2011 women made up 12% of Chartered Geologists, up from 7% in 2002.

The Society has never (of late!) been consciously exclusive, but greater awareness of the needs of individuals means we are more proactive in broadening gender and ethnic participation. Continued change over the next 25 years is inevitable, furthering wider diversity within our Chartered Fellowship.

Confronting barriers to inclusion

Confront barriers to inclusion or lose recruits to Earth science

George Jameson heralds a forthcoming conference on 'opening the gate to accessible fieldwork'.

Field experience is a crucial component in the professional practice of geoscience. All learners, regardless of their stage of education, should see geoscience as an accessible academic endeavour which offers viable career opportunities.

For learners with disabilities, however, the physical and psychological challenges presented by fieldwork, coupled with the rigorous schedule of fieldwork characteristic of most undergraduate programmes, can deter talented individuals from engaging with geoscience beyond compulsory education.

This one-day event explores the issues involved in making fieldwork accessible to learners with a diverse range of abilities. We welcome and encourage participation from geoscience educators, industry professionals, and organisations involved in the provision of fieldwork in both formal and informal capacities.

➤ How can we the wider geoscience community embrace this undertaking to attract and foster the talents of people with diverse abilities?
Join us at Burlington House on Friday 26 June and take part. Registration is now open – visit **http://bit.ly/1OOxxUv**

NEWS IN BRIEF

Geological Society Club

The Geological Society Club, successor to the body that gave birth to the Society in 1807, meets monthly (except over the field season!) at 18.30 for 19.00 in the Athenaeum Club, Pall Mall, or at another venue, to be confirmed nearer the date. Once a year there is also a buffet dinner at Burlington House. New diners are always welcome, especially from among younger Fellows. Dinner costs £57 for a four-course meal, including coffee and port. There is a cash bar for the purchase of aperitifs and wine. Burlington House dinners include wine.
2015: 9 September (Athenaeum); 7 October (Athenaeum)
➤ Fellows wishing to dine or requesting further information about the Geological Society Club, please email Caroline Seymour on carolineseymour554@hotmail.com

Careers Day 2015

The Geological Society's Careers Days are the most recognised geological careers-based forum in the UK. These events are a great opportunity to showcase your company to aspiring early career geoscientists – the future of your industry! For more information about the opportunities available, visit: www.geolsoc.org.uk/careersdaysponsorship

Awards 2016

Make your nominations for our 2016 Awards, writes Stephanie Jones. Fellows of the Society are invited to submit nominations for the Society's Awards for 2016 to the Awards Committee. Full details of how to make nominations can be found at www.geolsoc.org.uk/gsl/awards. Nominations must be received at the Society no later than 1 October 2015.

SOCIETY*NEWS...*

'University Geoscience UK'

The body formerly known as the Committee of Heads of University Geoscience Departments (CHUGD) has a new name, write Tim Minshull* and David Manning§

The Geological Society and the Committee of Heads of University Geosciences Departments (CHUGD) have increasingly worked together to represent the university geoscience community to government and others regarding higher education and research matters, to share information and to promote the study of geoscience at universities. During 2014, a GSL-CHUGD working group developed proposals for a new model of closer cooperative working, building on recent progress.

New Name

From July 2015, CHUGD will work under the new name of 'University Geoscience UK'. A new Joint Higher Education Committee has been established by our two organisations, to address the needs and promote the interests of geoscience students, researchers and teachers in UK universities. The Society will provide administrative support and will lead delivery of a shared programme of activities and communications. University Geoscience UK will continue as an independent body and a small executive committee (with secretariat provided by GSL) will oversee its activities and its input to the new joint committee.

A full meeting of University Geoscience UK will be held annually, starting this November. This will provide an opportunity for representatives from all UK geoscience departments to discuss in depth a small number of strategic matters. The 2015 discussion meeting is planned to focus on field teaching. The executive committee will remain in contact with University Geoscience UK members throughout the year – the engagement of this wider group is essential if we are to represent our community effectively to government and others, and provide valuable support to students and academics.

The new closer working relationship between our two organisations and the changes to University Geoscience UK's methods of working have been approved unanimously by Council and by University Geoscience UK's membership. We are excited about the opportunities that this relationship will afford our two organisations – and, more importantly, the university geoscience community – building on recent successes.

We believe it will strengthen input to joint responses to government consultations and Parliamentary inquiries by University Geoscience UK, on behalf of the community it serves. It will also provide a simple mechanism for the Society to better access the expertise of University Geoscience UK, as well as to support its services and activities. In this way, we believe that our new model of working will allow us to maximise the impact of our two organisations' respective expertise, capabilities and capacities.

Work Plan

The new joint committee is now developing an initial work plan. Early priorities are to gather reliable information on the full costs of field teaching to support communication with government and funding bodies; to improve provision of career and further study information to those at school, university and beyond; and, working with the American Geosciences Institute, to survey those completing geoscience degrees to find out more about the paths they have taken and their future plans.

We welcome comments and suggestions from University Geoscience UK members and Geological Society Fellows regarding future plans and activities. Please contact **nic.bilham@geolsoc.org.uk.**

**Chair, University Geoscience UK; § President, The Geological Society*

Transforming for the future

Mike Bowman, Professor of Development & Production Geology, University of Manchester, will chair a session at the 8th Petroleum Geology of Northwest Europe Conference (PGC) this September.*

Geoscientist: *How should the North Sea sector adapt its practices to ensure the most efficient exploration and extraction of remaining resources?*

MB: I see a number of areas where industry could make a bigger impact and build on the momentum being set up by the creation of the Oil & Gas Authority and the appointment of the new regulator together with the recent government tax changes. We need greater collaboration across operators, service sectors, academia and other SMEs through sharing of knowledge and information and learning from each other more effectively.

Geoscientist: *What is your view of onshore unconventional gas and oil exploration in Europe? Is the prize worth the pain?*

MB: Given the pace of growth in the global demand for energy and the need for hydrocarbons, together with security of supply concerns and the pretty dismal track record of global exploration for conventional oil and gas in recent years, I feel we should do all that we can to safely and securely explore for both conventional and unconventional resources in our own region. The value of shale and also conventional gas as a clean fuel that will help bridge to a less hydrocarbon dependant future is clear and we should be doing all we can to support this and make it happen.

Geoscientist: *What technologies will shape the industry in the next 10–15 years?*

MB: I see four areas here – one will be transforming the unconventional shale based exploration and production through new and more advanced drilling, completion and stimulation technologies. Secondly, in the North Sea and related mature basin we must create novel solutions that will help transform those many small, currently uneconomic, resources and create value from them. This will require low cost, simple and increasingly automated engineering solutions that will improve operating efficiency, reduce operating costs and also the capital costs of a new development.

Geoscientist: *Do you foresee North Sea infrastructure being significantly re-purposed for alternative energy use such as CCS or hubs for electricity transmission?*

MB: I remain astonished that there is such little activity in this broad and important area. There seems to be very little incentive or push from government. We must do all that we can to reduce emissions, better manage our footprint and make better use of our infrastructure from a broader energy perspective.

***PGC8, 28–30 September 2015**, Queen Elizabeth II Conference Centre, London (see advert, p4) The full interview with **Mike Bowman** may be found in Geoscientist Online*

Diversity, Equality and Inclusion

The Geological Society (Edmund Nickless writes) thanks all fellows and candidate fellows who have completed and returned the Diversity, Equality and Inclusion Survey.

We have received a modest number of returns which will help tremendously in our efforts to identify and address any actual or perceived barriers to inclusion and to measure our success at improving diversity over time.

The survey is not compulsory and will remain so - but in order for us to achieve our aims we would love as many people as possible to complete and return it. This will allow us to develop a more accurate picture of the Society's demographic. We can then direct our resources to where they are required, allowing us to benchmark progress.

> THE SURVEY IS NOT COMPULSORY, BUT WE WOULD LOVE AS MANY PEOPLE AS POSSIBLE TO COMPLETE IT

If you haven't already completed the survey, please do so. Fellows and Candidate Fellows can complete the Survey form via their online accounts, by logging in to their 'MyGSL' dashboard on **www.geolsoc.org.uk**

FUTURE MEETINGS

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

Ordinary General Meetings:

- **2015:** 22 September
- **2015:** 25 November
- **2016:** 3 February
- **2016:** 6 April

Meetings of Council:

- **2015:** 22 September
- **2015:** 23 September
- **2015:** 25 November
- **2016:** 3 February
- **2016:** 6 April

Re-fitting the flagships

A Science Committee working group on Society Flagship Meetings has reported, writes Al Fraser.

Flagship Meetings have formed the mainstay of our science communication to Fellows and non-fellows for many years. 'If it ain't broke don't fix it' came to mind; but we very quickly found that there were a few strategic changes we could make to bring them up to date and enhance the Society's overall scientific output.

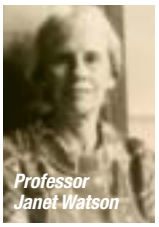
The group met on 11 December 2014 and made a series of recommendations, subsequently reviewed by Science Committee and SERC in February and March and approved at Council on 8 April. I want to share these proposals at an early stage and particularly ask for your support in identifying subject matter and suitable conferences to populate our new Flagship Meetings calendar. I also wanted to bring two exciting new events to your attention that will be joining the line-up, details of which can be found on **www.geolsoc.org.uk**.

The **William Smith Meeting** was identified as a 'blue ribbon' event and the working group agreed there should be no change in its remit.

The **Lyell Meeting** will continue to report annually on and discuss key science in stratigraphy.

The Fermor Meeting has traditionally been held every two to three years but there is no reason why it can't be annual. Let's have some proposals please!

The remit for the **Arthur Holmes Meeting** will be re-written to emphasise the substantial field-based activity required. Novel formats will be welcomed (e.g. a field meeting with a short conventional conference attached) and it can be on any aspect of geoscience. The conference doesn't have to be held at the Society and could take place near to the fieldwork. And we would like to encourage conference proposals with an element of student field teaching.



Professor Janet Watson

The group agreed that the focus for the **Frontiers Meeting** should be on early career geoscientists presenting research to their peers and potential industry employers, and should predominately be discussion-led. Frontiers Meetings were originally also intended to provide an opportunity for early career scientists to propose and organise meetings themselves, to gain convener experience. This aspect has not been successful. It was agreed that meetings of this type need to be facilitated by a convener who is not necessarily an early career researcher, but who can stimulate the involvement of this community. In an important change, the group agreed that the title 'Frontiers' (originally meant to refer to cutting-edge areas) was not helpful. In future this meeting will be called **'The Janet Watson Meeting: an early career geoscience symposium'**.

There is no obvious opportunity within the current range of flagship meetings to address the 'societal challenges' outlined in the 'Geology for Society' report, most at present being research-based. Although some are more applied (or mixed), the group noted that such meetings nonetheless tend to focus on an area of science (as per the 'subject map' in our science strategy) rather than on societal application.

Professor Bryan Lovell

The group therefore proposed a new flagship meeting series to focus on societal challenges and the geoscience relevant to addressing them. The group noted that the 'Geology for Society' report is a useful starting point for potential topics and proposed that the new series be called the '**Bryan Lovell Meeting**', after former President Bryan Lovell (picture). Bryan has enthusiastically supported this proposal and plans to be present at these events when they kick off in late 2016 or early 2017.

Please forward meeting proposals for the **2016/2017** flagship meetings to Laura Griffiths, Conference Manager, **laura.griffiths@geolsoc.org.uk**.

STEPS AND CYCLES

Sink or swim? Stepwise climate change, if real, can be explained statistically

Andy Chadwick*

explains how interaction between continuous trend with natural climate cycles produces the observed stepped pattern of global warming

Climate-change 'sceptics' have made great mileage out of the current hiatus in observed global warming. Atmospheric temperatures have not really increased since the turn of the 21st Century, a fact frequently cited as incompatible with, or even disproving, global warming.

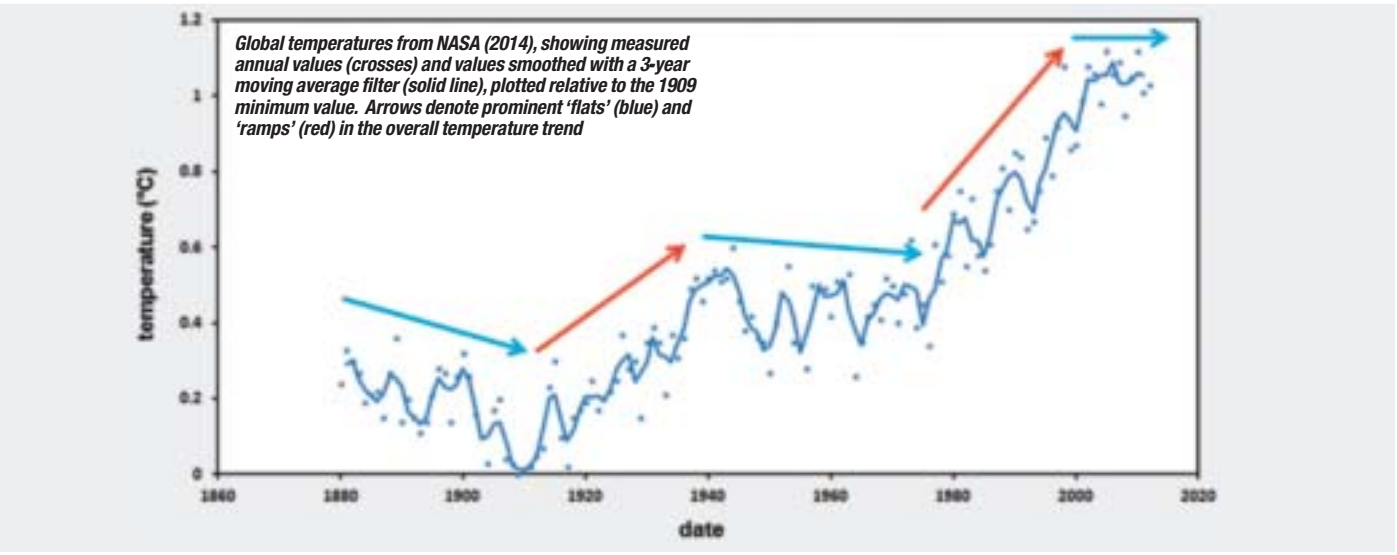
These same commentators draw a discreet veil over the fact that temperatures also didn't rise between 1940 and 1970 - an inconvenient truth for them, since that pause was followed by 30 years of rapid warming.

However, the truth is that a long-term rising temperature trend, steepening with time, has lifted average global temperatures by around 0.9° C since the early 20th Century. This long-term trend correlates closely with the rise in atmospheric CO_2 and with its expected greenhouse warming effects. But anthropogenic emissions are not the only game in town, and that is why the observed temperature variation is more complex.

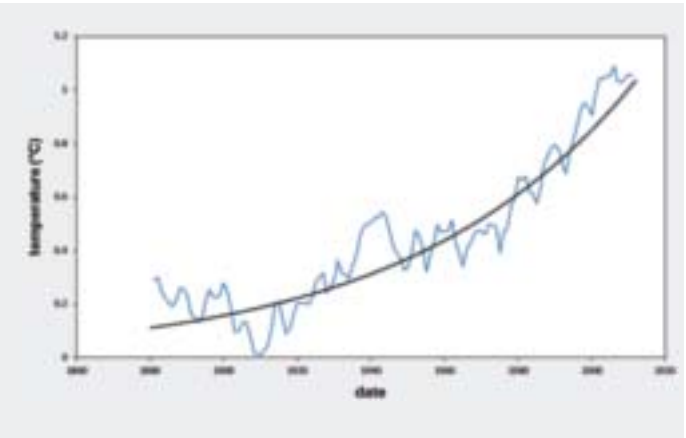
The basic picture of long-term warming is in fact characterised by thirty-year 'ramps' (where temperatures rise relatively quickly), alternating with thirty-year 'flats', where temperatures either fall slightly, or remain roughly constant. The latest 'flat' commenced around the year 2000.

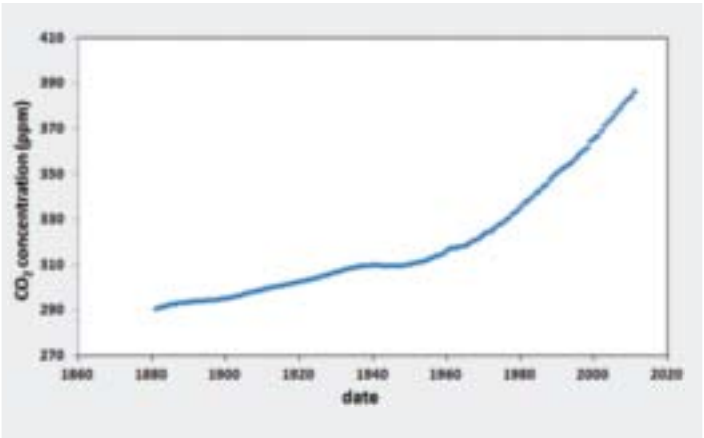
It is relatively easy to set out, simply and without complex modelling, the way in which global temperatures and atmospheric CO_2 concentrations have changed over the past century and more. By teasing apart the different natural, shorter-term variations that affect the atmosphere, we can show quite clearly why we should not expect temperature increases to be as smooth

> THE BASIC PATTERN OF LONG-TERM WARMING IS CHARACTERISED BY 30-YEAR 'RAMPS' ALTERNATING WITH 30-YEAR 'FLATS'



Global temperatures from NASA (2014), showing measured annual values (crosses) and values smoothed with a 3-year moving average filter (solid line), plotted relative to the 1909 minimum value. Arrows denote prominent 'flats' (blue) and 'ramps' (red) in the overall temperature trend





Lower left: Smoothed global temperatures with best-fit power-law curve to show long-term trend. Atmospheric CO_2 levels Data on CO_2 levels comprise online measurements from the modern instrumental record[5] combined with online measurements from older periods gathered from inclusions in ice-cores from the Antarctic ice-sheet[5]

Lower right: Atmospheric CO_2 levels 1880 to 2012 based on ice-core data from Law Dome Antarctica 6 and Mauna Loa[5] (Scripps 2014)

as the rise in CO_2 content, and how it is that the interference between the steady curve and the different cyclicities produces just the stepped graph that is observed. From there we can make predictions of how temperatures are likely to change over the next 50 years or so, assuming these patterns continue.

It was Swedish physical chemist Svante Arrhenius (1859-1927) who wrote1 in 1896 that "…..if the quantity of carbonic acid [in the atmosphere] increases in geometric progression, the augmentation of the temperature will increase nearly in arithmetic progression". Arrhenius rather welcomed the idea of global warming and optimistically predicted that Scandinavian climates might become more equable. Although our understanding of how climate is affected by different greenhouse gases has become much more sophisticated since then, Arrhenius's basic thesis still stands today.

Datasets

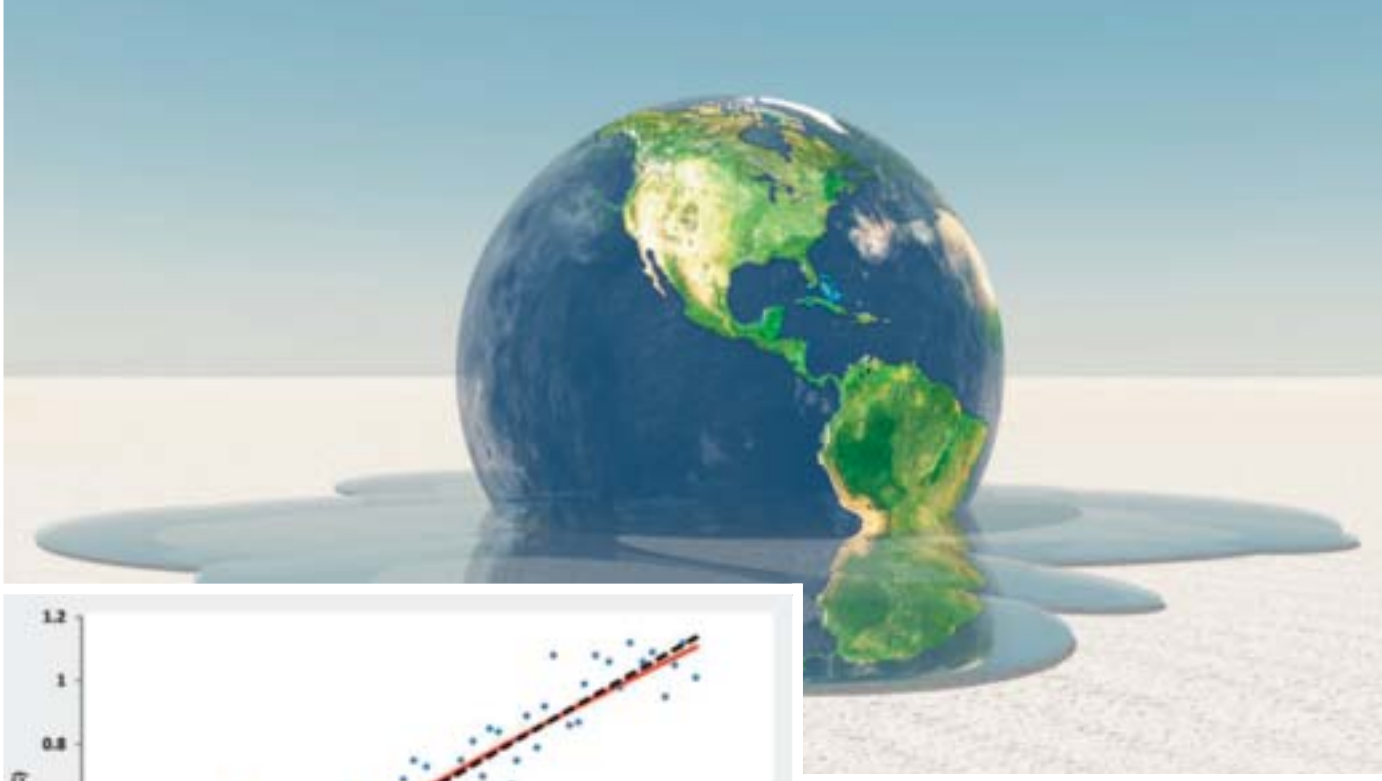
A number of long-term global temperature datasets exist and are publicly available. Some are restricted to measurements taken on land[2] and others covering the entire Earth's surface[3]. Here we use the NASA database[4] , available in tabular form online. The dataset comprises temperature measurements from 1880 to the present day expressed as temperature difference relative to the 1951-1980 mean. Here, for clarity, we redisplay them as temperature difference relative to the lowest recorded annual value (in 1909).

The raw data are quite noisy, with significant year-to-year variation, so a simple three-year moving average filter has been applied to smooth these out and make it easier to see the overall variability.

The most obvious aspect of the dataset is a hundred-year warming trend, from the early part of the 20th Century to the present day. This can be illustrated by fitting a simple power-law curve to the data. As defined by the power-law fit, global temperatures today are some 0.8 – 0.9°C higher than they were during the latter part the 19th Century.

Measured annual temperatures do not follow the long-term trend exactly, but rather include a number of pronounced multi-decadal variations. These are characterised by 'ramps' (periods of roughly 30 years when temperatures rose rather rapidly) and 'flats' (periods of roughly 30 years when temperatures decreased slightly or remained roughly constant).

Thus, and running counter to the overall warming trend, temperatures fell significantly between 1880 and 1910, ▶



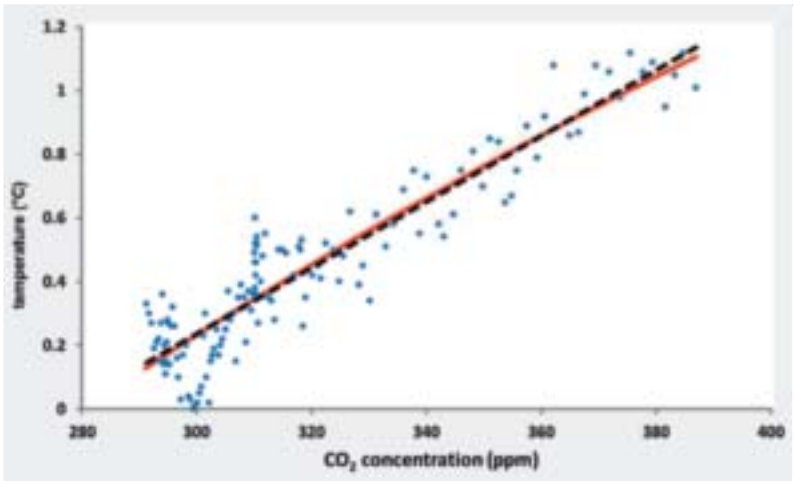


Figure 4: Global temperatures plotted against atmospheric CO_2 levels (1880 – 2012) showing a linear fit (dashed black line) and a logarithmic fit (solid red line)

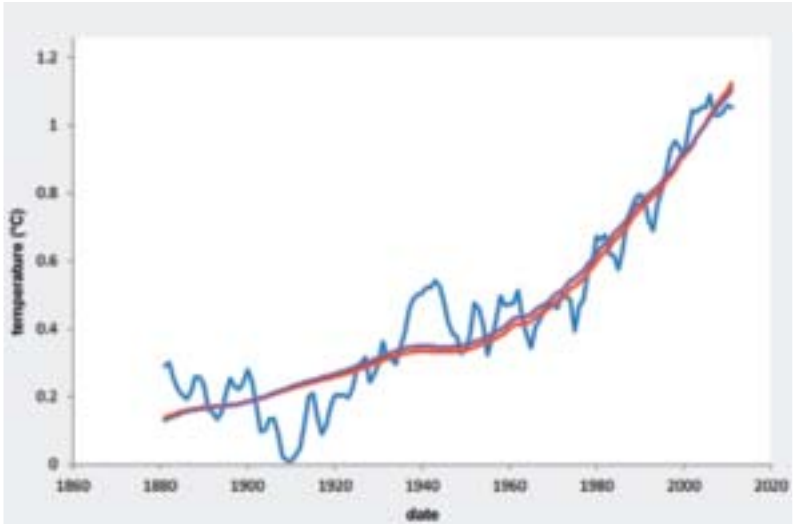


Figure 5: Observed temperatures (solid blue line) and CO_2-scaled temperatures using the linear (red line) and logarithmic (purple line) temperature – CO_2 correlation functions from Figure 4

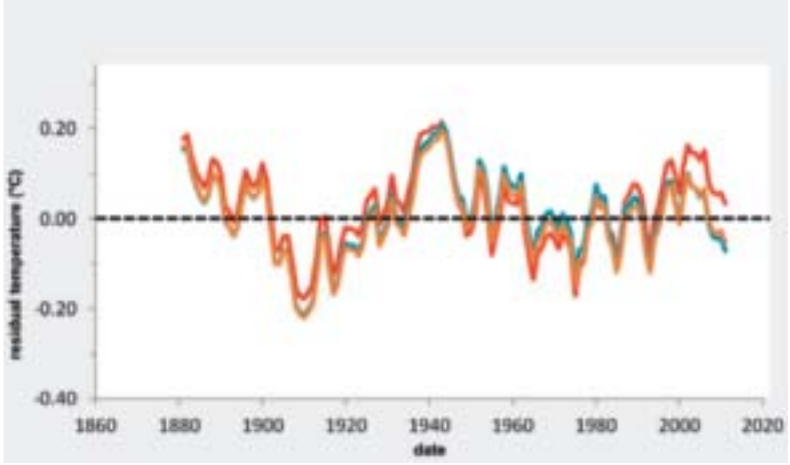


Figure 6: Residual global temperature variations 1880 – 2012 derived by subtracting the long-term trend curves from the observed data. Residuals from the power-law fit and the linear and logarithmic scaled trends are denoted by the red, blue and brown lines respectively

decreased slightly in the 30-year period 1945 to 1975, and have remained roughly constant since the end of the 20th Century to now. Viewed in this context, the current 'flattening off' of global temperatures seems to be part of a rather regular pattern.

CO_2 data show a significant increase, from around 290ppm at the end of the 19th Century, to nearly 400ppm by the present day (CO_2 levels at Mauna Loa observatory (Hawaii) reached 400ppm for the first time on 9 May, 2013). Like the long-term temperature trend, the rate of CO_2 increase is not itself constant, but accelerates steadily with time. In general terms, it is clear that with time (particularly in the second half of the 20th Century), higher atmospheric CO_2 concentrations are associated with higher temperatures.

Correlations

Cross-plotting CO_2 levels and temperature shows a direct correlation. The simplest fit to the data is a simple linear function, with a gradient of around 0.1°C for every additional 10ppm of CO_2. Other, more complex, fits can be made. For example, a logarithmic function gives an equally satisfactory correlation.

Applying the two correlation functions to the CO_2 observational record gives equivalent 'CO_2 – scaled' temperature records. These two scaled curves essentially represent the component of the observed temperature record that correlates with CO_2, and excludes any shorter term variability.

These curves also include the effect of other greenhouse gases that have also accumulated in the atmosphere, over similar timescales to CO_2 – methane, for example. For simplicity we shall just use the term 'CO_2-scaled' temperatures.

CO_2-scaled curves produce a match to measured temperature data that is much superior to the empirically-fitted power-law curve. This is quite remarkable, given that the power-law curve is derived purely from the temperature data, whereas the scaled curves depend on the relationship between CO_2 and temperature.

Short-term temperature variation can be isolated by subtracting long-term trends from the observed data, to obtain 'de-trended' or 'residual' temperatures. These residual temperature variations have no correlation with CO_2 and so can be thought of as a response to natural or other shorter-term processes.

By simply looking at the curves, one can discern a number of cyclical components. The strongest of these by far has a periodicity of around 60 years and corresponds to the obvious 'multi-decadal cyclicity', which has a variability approaching ± 0.15°C, with peaks around 1880, 1940 and 2000 and troughs around 1910 and 1970. Smaller, shorter-term components seem to display periodicities in the range of five to 20 years or so, contributing decadal variations in the order of ± 0.01°C.

Spectral analysis provides a more rigorous way of determining cyclical variations within time series like these. Application of a Fast Fourier Transform (FFT) to the residual temperature curve (obtained after subtracting the logarithmic fit between CO_2 and temperature) gives the power spectrum shown in Figure 7.

The peaks in the spectrum indicate the presence of discrete cyclical components. In fact, the peaks are all distributed across several frequencies - so we compute the 'true' frequency as the weighted average of those frequencies comprising the spectral peak. The reason for doing this is that a spectrum computed by FFT is evaluated at frequencies fixed by the sampling frequency and the number of samples in the data sequence. So, for our input sample size of 131 years (with sampling every year) the periods of the first three frequency components are: infinity (by definition, the constant term), 131 years, 65.5 years and 32.75 years (i.e., the period halves with each successive spectral estimate).

The weighted averaging helps compensate for the effect of undersampling, which is most important at the low-frequency end of the spectrum, where gaps between adjacent periods are largest. By taking weighted averages of the frequencies that make up peaks A, B and C, we determine periods of 59.9, 20.3 and 14.6 years respectively.

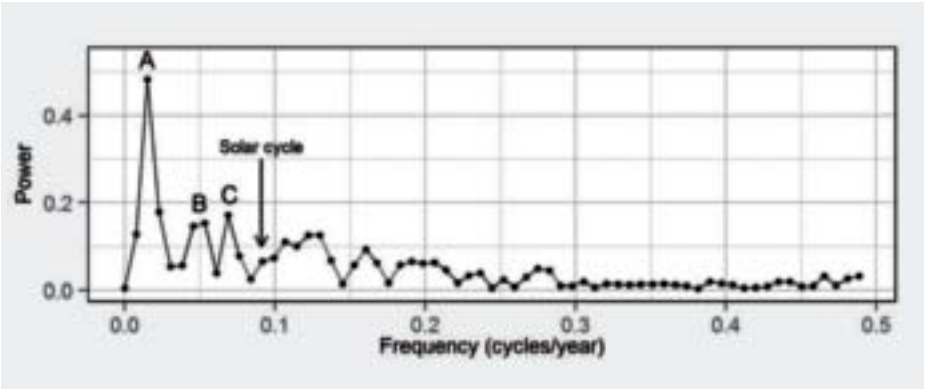
The phases of the three cyclical components were similarly estimated by averaging the individual phases of spectral components making up the peaks in the power spectrum, weighted by their respective powers. Smaller peaks in the spectrum (associated with cycles of less than 10 years) were not considered.

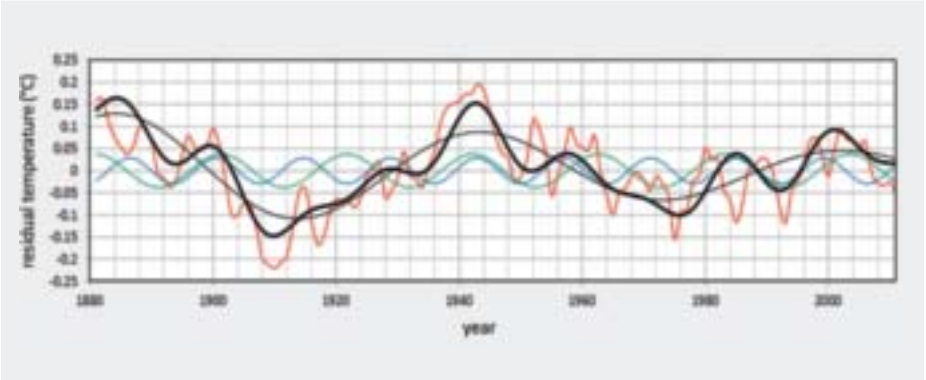
A synthetic curve, incorporating the three principal cyclic components, is shown in Figure 8, using the identified frequencies and phases of the principal spectral components. This captures well the multi-decadal variations in amplitude of the observed temperature residuals. (We have not included higher frequency components from the spectral analysis, partly for simplicity, but also to avoid giving a false impression of precision when extrapolating the data into the future).

Close match

It is clear that the long-term warming trend extracted from temperature data closely matches the observed rise in atmospheric CO_2 concentrations. In particular it matches well the temperature trend scaled from the logarithm of CO_2 concentration - the relationship first proposed by Arrhenius. ▶

> IT IS CLEAR THAT THE LONG-TERM TREND FROM TEMPERATURE DATA CLOSELY MATCHES THE OBSERVED RISE IN ATMOSPHERIC CO_2 CONCENTRATIONS





Below: ***Figure 7: Power spectrum of the residual temperature variation showing distinct peaks at several frequencies. The largest components (peaks A, B and C) are associated with periods greater than 10 years and have estimated cyclicities of 59.9, 20.3 and 14.6 years respectively. We also indicate where the 11-year solar cycle would plot on the spectrum***

Below lower: ***Figure 8: Synthetic time series of temperature residuals (thick black) reconstructed from three sinusoidal frequency components corresponding to the spectral peaks in Figure 7 associated with periods of 59.9, 20.3 and 14.6 years (denoted by the thin black, green and blue lines resp.). The observed temperature residual is shown in red. A linear decay of amplitude with time has been applied to the lowest frequency component***

The shorter term variations correlate with a number of natural oceanic circulation phenomena, all of which are associated with enormous heat exchanges between the oceans and the atmosphere[7]. The dominant ~60 year temperature periodicity is comparable with a 60-year cyclicity in global sea level[8] and is correlated with the Atlantic Multidecadal Oscillation[9]. Other shorter-term cyclic phenomena further complicating the record include the Pacific Decadal Oscillation and the more notorious 'El Nino'.

Additional, non-cyclic events all add 'noise' to the longer-term temperature record. Of these, the most important natural process is volcanicity, which produces dust and atmospheric aerosols that act as transient cooling agents. Human activity is also variable in the short term, notably in the production of aerosols and carbon particulates. It seems the 11-year sunspot cycle has no discernible imprint on the temperature record.

For simplicity, we shall refer to all these non-CO_2 related multidecadal/decadal temperature effects as 'natural' variation.

Ramps and flats

The prominent 'ramps' and 'flats' in the temperature curve can readily be explained as the interaction between the long-term warming trend (steepening with time) and the dominant ~60-year cyclic variability.

Thus from ~1880 to ~1910, the still relatively gentle long-term rising trend (of 0.03°C per decade) was outweighed by a fall (of 0.13°C per decade) in the 'natural' cycle to produce an overall cooling over 30 years of about 0.3°C.

From ~ 1910 to ~1940, the long-term rising trend (by then increased to 0.04°C per decade) was enhanced by a 30-year (0.12°C/decade) rise in the 'natural' cycle, to produce a ramp in temperatures of about 0.5°C in 30 years.

From ~ 1940 to ~1975, the long-term rising trend (now up to 0.07°C per decade) was just outweighed by a 35-year (0.09°C per decade) fall in the 'natural' cycle - to produce a slight cooling over 35 years of 0.07°C.

From ~1975 to ~2000 the long-term rising trend (which by that time had reached 0.12°C per decade) was enhanced by a 25-year (0.08°C per decade) rise in the 'natural' cycle, resulting in an increase of over 0.5°C in 25 years - the fastest rise yet recorded.

And so, from 2000 to the present, the latest downswing in the natural cycle is just about balancing the rapid underlying upward trend.

Looking ahead

What are the implications of this for future global temperatures, assuming continued increase in atmospheric CO_2?

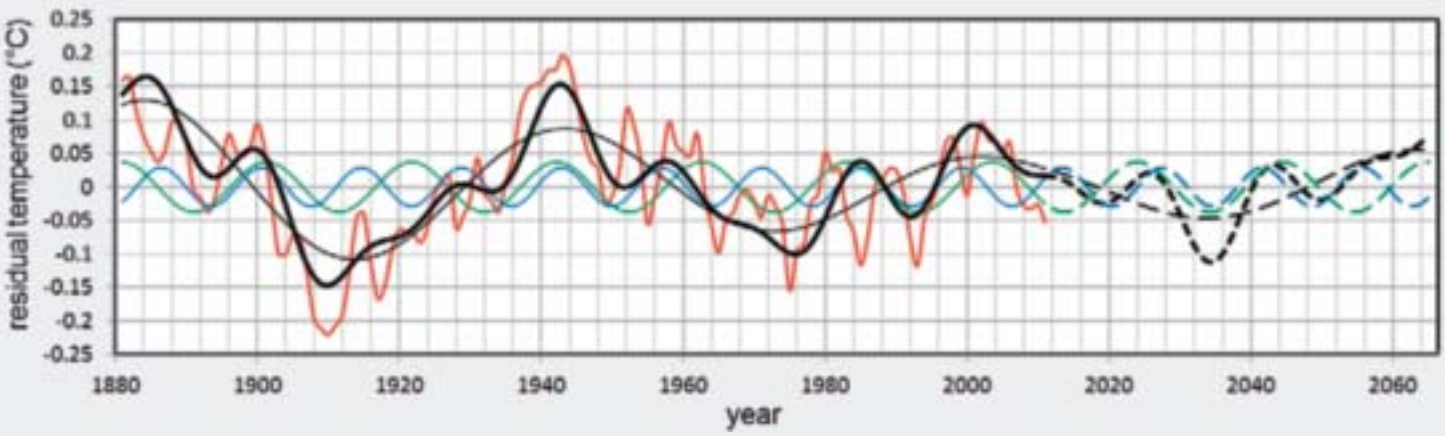
The first step is to extrapolate the synthetic residual function forward by 50 years or so. This has been accomplished by extrapolating the three sinusoidal frequency components (with periods of 59.9, 20.3 and 14.6 years) to around 2070, and summing them.

The second step was to project forward the long-term rising temperature trend, scaled from the logarithm of CO_2 concentrations. To do this, we assumed that atmospheric CO_2 would rise at a constant increment of 1.69ppm per annum - the average value from 1990 to 2012. (Recent yearly increases suggest that this might be rather conservative.)

Summing the projected synthetic residuals and the projected long-term trend gives a synthetic temperature curve that provides an estimate of future global temperature. It is clear that in coming decades temperatures will continue to rise, albeit not at a uniform rate.

The latest down-swing of the ~60 year cycle, which started around the turn of the century, will probably restrict average global temperature-rise to around 0.1°C per decade until around 2035; but this will increase to around 0.2°C per decade as we enter the next 'ramp'.

Clearly this is just an estimate and subject to uncertainties. Take, for instance, short-term variation. As discussed above we have not included cyclicities with periods of less than about 15 years, mainly to avoid a false impression of precision in the forward projection. Our temperature curve cannot therefore capture this type of variability. Thus, while our curve indicates the general warming slowdown that we have witnessed since 2000, it



Synthetic and observed residual temperatures time series as for Figure 7 but with the synthetic components extrapolated into the future (dashed lines)

does not accurately replicate the actual flattening, which would require the addition of shorter-term variables.

Our analysis shows that the ~60 year periodicity is the key factor, which we interpret to be mainly responsible for the prominent ramps and flats observed in the recent temperature record. The evidence runs to just over 130 years of data however - barely more than two complete periods; so the longer-term stability of this cycle is open to question. Rohde et al. produced a temperature record back to around 1750[10]. The ~60 year periodicity is discernible on this, at least as far back as the early 1800s; but before this the record becomes increasingly uncertain.

Conclusions

Our analysis shows a number of interesting patterns and interactions in the global temperature record. A long-term rising trend, steepening with time, has lifted global temperatures by around 0.9° C from the early part of the 20th Century. Superimposed on this, a decadal to multidecadal cyclic variability imposes shorter-term temperature variations in the order of ±0.15°C.

The long-term rising trend correlates closely with the rise in atmospheric CO_2 and with its expected greenhouse warming effects. The shorter-term cyclic variability is a 'non-greenhouse' effect, influenced by some aspects of human activity, but principally the result of natural processes - in particular, large-scale multi-decadal to decadal oscillation of the oceanic circulation system.

Taken together, natural cyclic variation and the underlying rising trend produce the observed global temperature curve. When natural cyclicity acts against the greenhouse trend we get a temperature 'flat', while when the two act in unison we get a temperature 'ramp'. The ramps are getting steeper with time, and the flats (which were initially characterised by cooling) are no longer.

Projections suggest that CO_2-driven warming will continue, initially ameliorated by the current down-swing in natural cyclicity. However as this unwinds, temperature increase will accelerate from around 2035. Shorter-term variability might disguise these trends for periods of a few years or so.

There is a significant chance therefore that the current warming 'hiatus' might continue for a number of years. But it is critically important that this is not allowed to derail climate-change policy. The current hiatus is not 'buying us time' in any sense. As the natural cycle unwinds, and we enter the next ramp, excess energy stored in the oceans will be released back into the atmosphere, and temperatures will rise again - in all probability, more quickly than before. The climate change consensus[11] is not threatened by the current apparent lack of global warming. ◆

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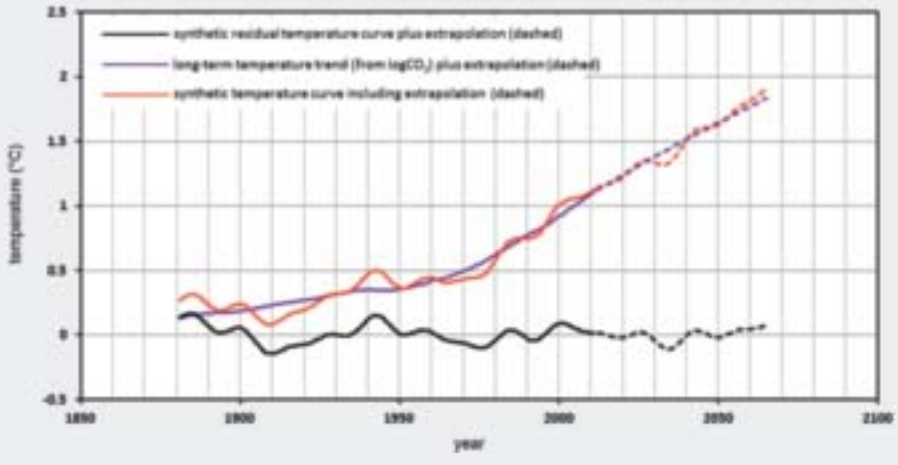

Figure 10: Future projection of temperature trends, showing the synthetic temperature residuals (1 - black), the long-term temperature trend (2 - purple), and the synthetic temperature curve (sum of 1 and 2)

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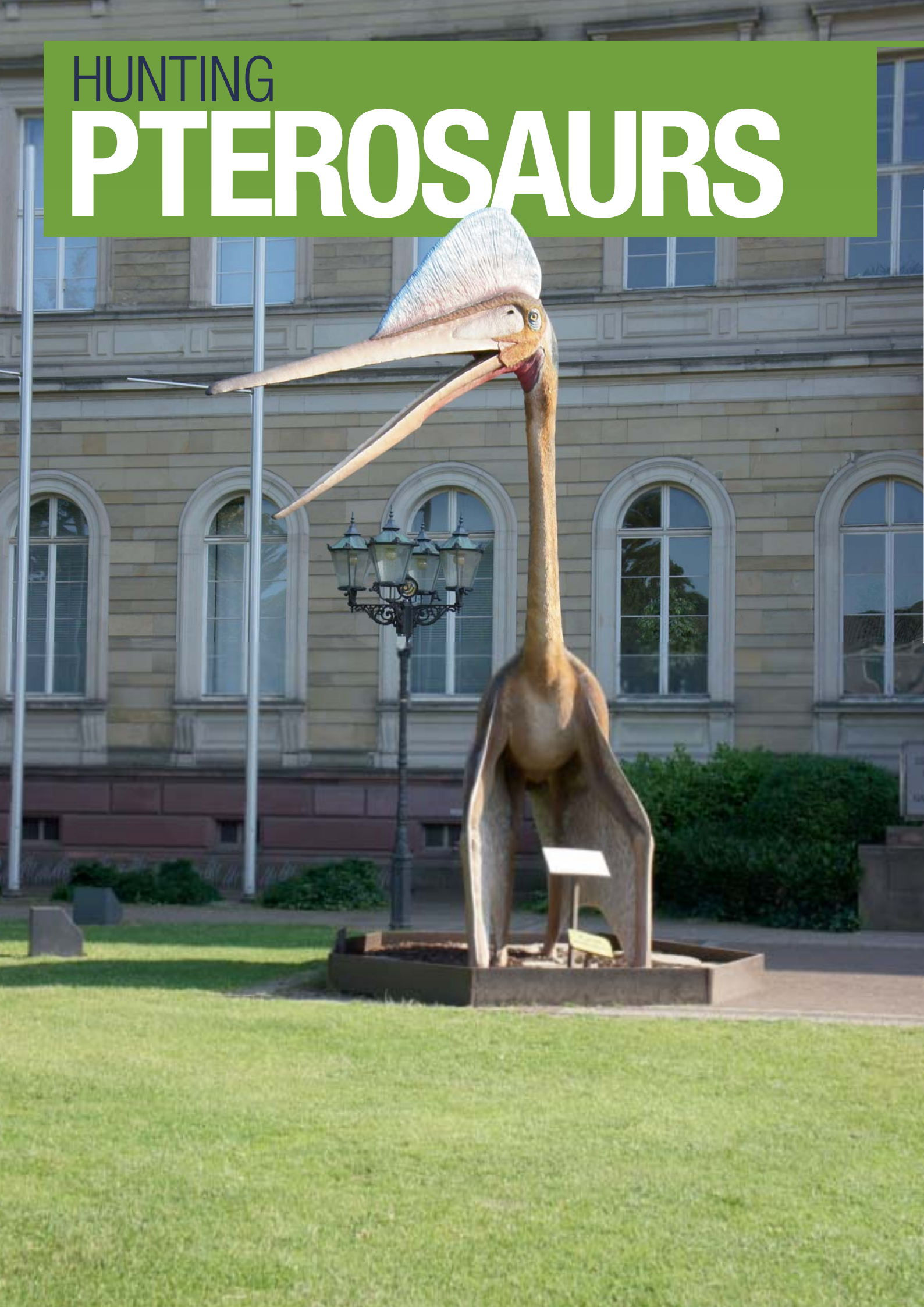
HUNTING PTEROSAURS



Elizabeth Martin-Silverstone* describes her investigations into pterosaur flight, and the evolution of flying vertebrates

Thanks to the Society's Daniel Pigeon Fund, I recently spent a few weeks travelling around Germany in search of pterosaur fossils in various collections.

Flight is a truly remarkable adaptation that has evolved only three times in vertebrates: in birds, bats, and in the extinct flying reptiles that are the subject of my studies - the pterosaurs. Of all these different lineages, pterosaurs produced the widest range of body sizes (with wing-spans ranging from 0.2 to 11m!), the largest overall size (the largest extant bird has a wingspan of 4 m, largest extinct was 7m) yet were also the first to achieve powered flight, first in the Late Triassic. Despite being known from the fossil record for over 200 years, basic questions on pterosaur biology and biomechanics - such as reliable body mass estimates and flight abilities - remain unknown.

Body mass

Estimating body mass is one of the most basic and essential features in understanding locomotory capabilities of an animal, and is even more important with respect to flying animals, because an animal's mass is directly proportional to its ability to take off and achieve lift. As the largest animals ever to take to the air, pterosaurs pushed the limits of aerodynamics, and as there remains much debate around whether or not these large pterosaurs could actually fly, making accurate mass estimates vital to our overall comprehension of them. Previous mass estimates have varied drastically depending on the methods used. For example, one of the largest pterosaurs (*Quetzalcoatlus northropi*) has been estimated at an improbably light 70kg[1], at a more reasonable 250kg[2] and very heavy 544kg[3].

Fortunately, modern imaging technology allows us to make accurate estimates of bone mass in relatively uncrushed specimens using computed tomography (CT) scans[4]. These take x-rays from several different angles, allowing the fossil to be visualised in 3D, and the volume of actual bony material within each element to be calculated. When multiplied by bone density, this gives you a mass estimate.

Finally, after the bones have been digitally visualised, muscle mass can be estimated by reconstructing the muscle attachments and muscle volumes. This should produce a more accurate estimate of total body mass. This is what I am working towards now. CT scans also give us an idea of the degree of 'pneumaticity', which allows for comparison between different elements and species through the bone's Air Space Proportion (ASP). This can also be performed using cross-sections, but these are less accurate[5].

Pneumaticity, which is the presence of air sacs and diverticulae that invade the soft tissue and bones as part of the animal's respiratory system, is also found in birds, some theropod dinosaurs, and sauropod dinosaur necks. ASP gives a quantifiable measurement of the pneumaticity, which has implications for the biomechanics of an animal as it directly affects the stiffness of a bone.

Zittel wing

So far, I have visited the collections of four German museums: Staatliches Museum für Naturkunde Karlsruhe (SMNK), Staatliches Museum für Naturkunde Stuttgart (SMNS), Institut für Geologie und Paläontologie, Universität Tübingen (GPIT), and the Bayerische Staatssammlung für Paläontologie und Geologie, Munich (BSPG). I have been able to take a large number of pictures to start understand the variation in ASP throughout the skeleton and in different species

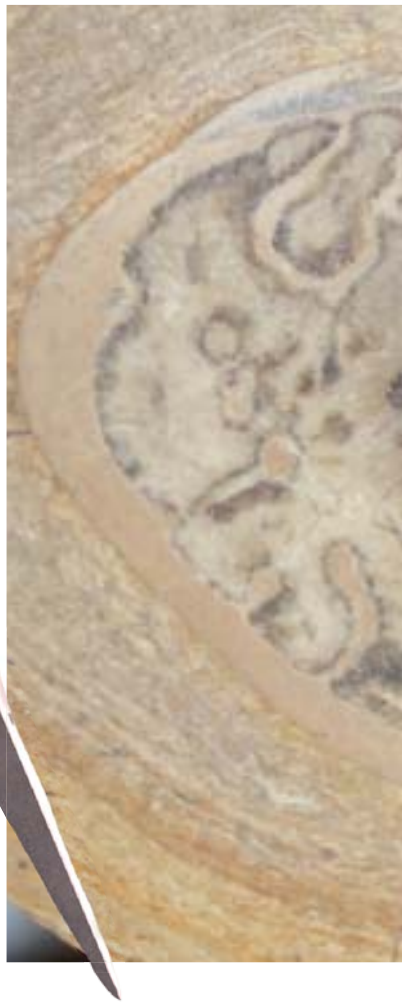
I greatly enjoyed the museum visits - especially Karlsruhe, where I was greeted at the front of the museum by a giant azhdarchid model and got to stay there (which felt a bit like *Night at the Museum*). There's also a giant fuzzy azhdarchid model in flight hanging from the ceiling of the museum! Munich was fascinating for the number of historically significant specimens in its collection, including the first pterosaur known to science (unfortunately that one is highly protected and I wasn't able to work on it). ▶

Above top: *Amazing giant flying azhdarchid model at the SMNK*
Above middle: *The famous 'Zittel Wing'* Rhamphorhynchus *specimen from the BSPG in Munich, known for the well preserved complete wing bones and soft tissue showing the shape of the membrane wing*
Above lower: *Cross-sectional image of a smaller pterosaur wing phalanx* (Rhamphorhynchus, *SMNS 59421*). *Scale markings indicate 1 cm*

Left: *An azhdarchid pterosaur model greets visitors to the Staatliches Museum für Naturkunde Karlsruhe (SMNK)*

Image by Mark Witton, used with permission

Flying azhdarchid pterosaur



I was completely surprised when I opened a drawer to discover the 'Zittel wing', the famous fossil that first gave us an idea of pterosaur wing structures, way back in 1880.

Trends

While the work is still very much in its infancy, some trends are becoming visible. First of all, ASP is consistently lower (meaning that there is proportionally more bone than air), in smaller pterosaurs (e.g. *Rhamphorhynchus, Pterodactylus, Germanodactylus*) than larger ones (e.g. *Ornithocheirus, Anhanguera, azhdarchid pterosaurs*). Previous studies have suggested that pterosaurs are among the most, if not the most, pneumatic animals to have lived[5]. However, this now appears to be true of only the larger pterosaurs, and is not the case for smaller ones.

As ASP refers to the physical amount of air present within a bone, (the degree of hollowness if you will) this can tell us something about biomechanics. Pterosaur bones probably underwent deformation in flight (as all bones do in movement), and would have been particularly susceptible to bending. The bending resistance of a hollow tube, related to the second moment of area, is dependent on the amount of material in the tube and how far from the centre it is (how large of a diameter the bone has). Pterosaur bones commonly have cortical thicknesses of 0.5-2mm. For two bones with a cortical thickness of one millimetre, the bending stiffness is much higher (i.e., it is more resistant to bending) in a bone with a diameter of 30mm than one with a diameter of 10mm.

Most pterosaur wing bones studied so far have ASP values ranging from 0.4-0.8, with very few exceeding 0.8. However, one pterosaur is showing much lower values, of just 0.1. This value was obtained from the dsungaripterid pterosaur '*Lonchognathosaurus*' from China. Dsungaripterids have been noted by pterosaur palaeontologists as having unusually thick-walled bones, which also affects their ASP. Modern birds that spend a significant time in water (such as cormorants, or penguins) have similarly thick-walled features, and dsungariperid palaeoecology is not fully understood. The implications of this thick-walled, low ASP feature are currently under investigation.

The main purpose of this study was to CT scan as many pterosaur fossils as possible to understand pterosaur bone and body mass. This is going ahead thanks to the large number of specimens on loan from the SMNK, including one nearly complete *Tapejara* [6], two partial ornithocheirid wings, one partial *Coloborhynchus* skeleton, and more. So far, only portions of the *Tapejara* have been scanned, but these have been very successful.

Future work

The main thing I have focused on during the last six months has been finishing the CT-scanning of all the SMNK specimens, and begin analysis - as the fossils need to be returned to Germany this month. I will also continue looking at the ASP, and how that affects the biomechanics of the pterosaur wing.

Depending on how much it will cost to return the specimens, I may visit additional museums in Germany as well, to collect yet more data. ◆

ACKNOWLEDGEMENT

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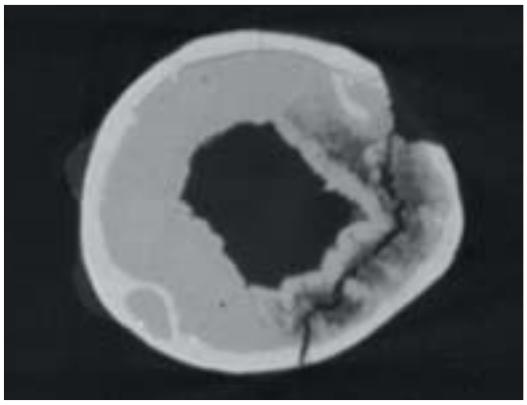
If you would like to find out more about Society fieldwork research grants, visit **www.geolsoc.org.uk/grants**. Applications for 2016 will be invited in September.

Cross-sectional image of a larger pterosaur wing phalanx that has been cut and smoothed (Araripedactylus, BSPG 1976 I 117). Trabeculae can be seen within the internal space. Scale markings indicate 1 mm



CT scan showing the cross-section of a long bone of Tapejara wellnhoferi *(SMNK PAL 1137). Cortical bone is seen around the outside as white, while trabecular bone is visible as thinner white bone coming off of the thicker outer cortex (bottom left)*

Assortment of specimens on loan for CT scanning from SMNK

Tapejara wellnhoferi *(SMNK PAL 1137)*

Fossils all packed up and ready for transportation several boxes, rolls of tape, and bubble wrap packs later!

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Fieldwork and mining

A rigorous dose of mine or exploration work allows students to decide if the life is for them, and employers to assess future employees, says **Mike Harris***

That fieldwork is essential to training geologists would seem a truism so universally accepted among geologists as to be unremarkable. However, although it is accepted in conversation, it is not always so at the point of financing it.

Mike Streule and Lorraine Craig (*Soapbox, Geoscientist 25.1 February 2015*) mention the sense of "being a 'real' geologist" that comes from seeing in the field what you have learned in a classroom. They write: "Yes, it is expensive, and yes, it takes dedicated staff to make it happen, but it makes [successful] geoscience graduates more truly valuable in the workplace than many others".

Mining colleagues

Not being involved, I cannot properly comment on university funding or how universities structure their programmes, but I can imagine the difficulties. My intention here is to address my mining industry colleagues, as we depend upon universities producing graduates with the basic skills we need; from there, we train them up. Our highest priorities are the ability to observe and record field data, and then to interpret it usefully.

Graduate geologists must be able to recognise minerals, rocks, structure and geomorphology accurately and record them in ways useful to us. Beyond that, they should be competent with the usual software packages, use imagery effectively, have a pragmatic understanding of the principles of geology, geophysics and geochemistry and know the basics about ore deposits.

But most valuable is a passion for being in the field, working on or looking for ore. They must be tough in the field, and enjoy it – and not be worried about less than balmy conditions - just appreciating the opportunity of being there. They must be able to get along with a range of people, often very different from themselves, and to cope with relatively high levels of responsibility early on.

Conditions v drawbacks

Some recent articles have expressed concerns over how the extractive industries can attract graduates if employment involves being in the field much of the time and/or posted abroad to difficult locations – my reply is that those who see these conditions as drawbacks are not the type of people we are after.

Although good university field training instils basic field skills, attracting the best to mining or exploration involves giving students an opportunity to see what our business is about – a very good way being to spend a summer working at a mine or exploration project. This is considerably more difficult and costly to organise than university field-trips, as it may involve work visas, often tedious to obtain, is expensive, and can be disruptive to small teams.

However, the payback can be high. Many mining/exploration geologists, myself included, were hooked on the industry through summer jobs. A rigorous dose of mine/exploration work will allow students to decide if such a life is for them and employers to assess if they think the students will make good future employees. The trick, especially in the current restricted financial environment, is to be highly selective about who is chosen.

* Dr Michael O Harris
CGeol works for RTZ

SOAPBOX CALLING!

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

If you can write it entertainingly in **500 words**, the Editor would like to hear from you. Email your piece, and a self-portrait, to **ted.nield@geolsoc. org.uk**. Copy can only be accepted electronically. No diagrams, tables or other illustrations please.

Pictures should be of print quality – please take photographs on the largest setting on your camera, with a plain background.

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

> "FIELDWORK IS ESSENTIAL: HOWEVER, ALTHOUGH ACCEPTED IN CONVERSATION IT IS NOT ALWAYS SO AT THE POINT OF FINANCE"

READERS' LETTERS

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

Morrison Shelter

Morrison shelters for Nepal?

Sir, The recent earthquake in Nepal has shown that many of the victims were killed and injured inside buildings by falling or collapsing masonry. During WW2, occupants were protected from building collapse during air raids by so-called 'Morrison Shelters', named for the then Minister for Home Security. These were prefabricated steel cage-like enclosures (picture). They were simple to make and erect (it was said that they could be put up by a pair of boy scouts!).

GRAHAM WEST

Executive Secretary - chartered, or 'charterable'?

Sir, Dick Selley's call *(Geoscientist 25.4, p21)* for applicants for the post of the Society's new Executive Secretary to be a Chartered Geologist (CGeol), while most laudable is, I believe, neither the most pragmatic nor necessarily the most ideal criterion.

To restrict applications to just this small pool would exclude many capable and deserving candidates. Selley says the Chief Executives of sister societies on Science Council – chemistry, physics and biology – were Chartered members of their discipline. Some of these, when applying, were not Chartered (or even non-Chartered) members of the body they went on to serve. Indeed, one of disciplines cited has found its past *three* Chief Executives among non-members - only becoming members, and indeed Fellows of their society, after accepting the post. Some have benefited from having a Chief Exec from outwith their discipline. Indeed, one has had a scientist from a wholly different discipline (albeit scientific) whose 28-year tenure saw membership increase by over 14,000.

Selley notes that some science bodies' Chief Execs are 'even PhDs', as if this were both relevant for an administrative post and a necessary badge of belonging. The Society is no longer even dominated *politically*, let alone numerically, by researchers. Science graduates carve out successful careers in many walks of life.

The post requires a mix of skills and getting it right is not easy. Indeed some (if not all) of our allied professional bodies have seen some Chief Execs leave office in less than ideal circumstances (folk who were relevant professionals with PhDs!). Let us not hamper our Council at this time with restrictive conditions.

JONATHAN COWIE

UK stone

Sir, Articles in June's *Geoscientist* and *Geoscientist Online* lead me to reflect on the sad state of the UK's stone industry (as opposed to aggregate).

I am having a new house built, and there is a requirement that 'the roof shall be of natural slate'. Clearly quite a few houses have roofs of fake (fibre-reinforced cement) 'slate'. The rest is Spanish or even Chinese, all much cheaper than Welsh slate. Scottish slate was always scarce as a result of geology, and is no longer extracted at all so is only available second-hand. Why should slate from Spain – an EU state – be so cheap despite greater transport distances? I also sought some walling stone, but none of the quarries still working flagstone in Caithness now produces it. The new house is near Dingwall, where no-one now quarries the distinctive, red, lower Devonian sandstone. I have managed to find some usable Moine psammite, which a local quarry saves from the crusher. It comes in handy brick-sized pieces as a result of close jointing and they have realised that there is a small market.

Why has UK-produced building and ornamental stone become so unavailable and unaffordable?

JOHN HEATHCOTE

Professional geologist needed

Sir, That the Executive Secretary should be a professional geologist is indisputable. However, the majority of professional geologists do not have chartered status: out of a membership of 11,606 a mere 21% (2495) are chartered. Therefore, I do not believe it should be essential for the Executive Secretary to have chartered status.

JOHN MURRAY

21%
(2495)
CHARTERED

The Desert - Lands of Lost Borders

This handsome book is informative, well-illustrated, broad-ranging, and clever. The author, a geologist and professional writer who in 2009 wrote the well-received *'Sand: A Journey through Science and the Imagination'*, has managed to weave together a whole array of different strands that serve to make deserts what they are.

Using some of his own field experiences, coupled with a wide reading of the literature, he has succeeded in covering the science of deserts (including climate, geomorphology, and wildlife), while at the same time discussing the human inhabitants, art and literature, and some of the arresting characters who risked their lives in discovering and traversing the world's drylands.

It aims, as the author explains, to 'provide an evocation, a celebration, a consideration of our response to the desert, the idea of the desert', for 'deserts are landscapes of the mind as much as physical realities, places of metaphor and myth.' Using examples from central Australia, the Namib, the Gobi, the Sahara, the Mojave and the Atacama, he examines such landscapes in the context of their place in history, as birthplaces of civilisations, evolutionary adaptations, art, ideology and philosophy. To be sure, it does not cover everything relating to this vast topic, but it provides a superb introduction to what makes deserts so fascinating and alluring.

To give an example of how different material is cleverly combined, consider his treatment of flash floods. The climatic and geomorphological conditions that produce them are described, and there are some graphic descriptions from the literature; but there is also a description of an explorer who was killed by a flash flood in the Algerian Sahara, Isabelle Eberhardt. We learn that she probably had syphilis, was illegitimate, was a habitual user of drugs, was highly promiscuous, and cut her hair like a man.

Equally, some pervasive surface features - stone pavements - are explained scientifically, but are also placed in the context of the disturbance of desert surfaces in the Libyan Deserts by the narrow tyres of Model T Fords used by great desert explorers like Ralph Alger Bagnold. Similarly, dust storms are introduced by a consideration of the life and writings of Mildred Cable and her colleagues in the Gobi, but this is followed seamlessly by a discussion of how the global importance of dust storms has been revealed by the latest satellite-borne sensors.

Lovers of deserts will love this book and will also learn much from it.

Reviewed by ***Andrew Goudie***

THE DESERT. LANDS OF LOST BORDERS by MICHAEL WELLAND, 2015. Published by Reaktion Books, 400pp (hbk) ISBN 978 1 78023 360 4
List price: £25.00. www.reaktionbooks.co.uk

Stratigraphic landscape analysis, thermochronology and the episodic development of elevated, passive continental margins

Extensive low-relief plateau surfaces at high elevation, termed 'peneplains' in this bulletin, have been a challenge to geologists seeking to explain the long-term evolution of rift-margin landscapes. Attempts to understand these plateaux have long focused on topography, leading to controversial theories of landscape evolution many of which have now been dismissed within current ideas of plate tectonic development of passive margins during continental fragmentation.

This extremely well illustrated book book provides a 'state-of-the-art' review of these landscapes with specific focus on new research, particularly with respect to the on-shore/off-shore sedimentary records which has led to a re-evaluation of such landscapes within a new scientific approach termed 'stratigraphic landscape analysis (SLA)' (Chapter three).

It provides a concise, thoughtful review of the topic, beginning wth the detailed research on Scandinavian and Greenland landscapes (previously carried out by the authors) before expanding discussion to include other continental passive margins in the southern hemisphere. The early part of the book presents a comprehensive introduction of key points regarding passive margins with useful definition and discussion of terminology, long a source of geological debate, and the formation of different types of surface allowing reconstructions of a relative chronology of landscape evolution. Chapter four introduces low-temperature thermochronology, particularly apatite fission-track methods, to provide a thermal history, thereby allowing better appreciation of the timing of uplift events and the calculation of the amount of bedrock erosion by denudation.

This is exemplified in Chapter five by a detailed investigation of West Greenland, demonstrating the utility of combining stratigraphic landscape analysis with thermochronology to establish multiple uplift and subsidence events following rifting of the continental margin. This is expanded in the subsequent chapter by assessment of the geological evidence from other passive margins, again emphasising that present-day topography may reflect a series of a sequence of episodic post-rifting tectonic and denudational events.

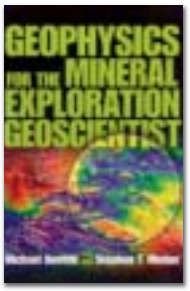
This allows the final chapters (seven and eight) of the book to evaluate critically a number of presently accepted hypotheses for the formation of such passive margin landscapes leading to revised interpretations that reflect the complicated sequence of post break-up uplift and subsidence events revealed by detailed stratigraphic landscape analysis.

Reviewed by ***Wishart Mitchell***

STRATIGRAPHIC LANDSCAPE ANALYSIS, THERMOCHRONOLOGY AND THE EPISODIC DEVELOPMENT OF ELEVATED, PASSIVE CONTINENTAL MARGINS by PAUL F GREEN, KARNA LIDMAR-BERGSTROM, PETER JAPSEN, JOHAN M BONOW & JAMES A CHALMERS Published by: Geological Survey of Denmark and Greenland. Publication date: 2013 ISBN: 978-87-7871-372-8
List price: DKK 250 + VAT 150pp W: www.geus.dk/publications/bull/nr30/index-uk.htm

Geophysics for the Mineral Exploration Geoscientist

Realistic estimates of the size and productivity of any oil or gas asset are essential for reservoir management decisions and minimising economic risk. An important estimation process in such



forecasting or comparison of different hydrocarbon recovery schemes and their economics is reservoir numerical modelling.

Reservoir models use the physically significant features that characterise the geologic, geochemical, and petrophysical controls of fluid flow. The needed data acquisition begins with field discovery through to the last phases of production and abandonment, but always direct knowledge of a reservoir is limited to a few drill-holes. In general, the large-scale features are most critical for the prediction of reservoir flow performance, and small-scale geological details summarised in effective properties at a larger scale. However all numerical models would be found in error if the inter-well volume were excavated and exhaustive measurements taken; there is always uncertainty.

The estimates of data distributions, if honed by statistical insights, can be more convincing. Geostatistics uses the geological origins of the data and how they vary in space and/or time. Using these statistically generated interpretations, alternative numerical models, (realisations), can be generated. The response of these realisations to, for example, time to water breakthrough, can be combined in a histogram as a model of uncertainty - geostatistical modelling.

This book describes how geostatistical reservoir modelling can contribute to making informed decisions by building and using numerical geological models of petroleum reservoirs which include geostatistical considerations. Beautifully prepared and illustrated, it details the practice, tools and techniques, and focuses on concepts and some important algorithms and examples from real reservoirs to illustrate those techniques. It uses work flow-charts to summarise operations.

Actual programmes are not given, but there is a list of sources where they can be found. Emerging developments are identified and briefly described. A glossary of relevant geostatistical terms and notation is provided as is an excellent bibliography, which provides a valuable resource for deeper detail, theory or software. The bibliography shows that the authors are pioneers in the subject and have contributed significantly. Finally there is an index.

This book would be a beneficial read for the practitioner wanting to understand the geostatistical tools and their usage in modern commercial programmes. It would be a good advanced undergraduate or graduate class text on modern reservoir characterisation and statistical modelling.

Reviewed by ***John Milsom***

GEOPHYSICS FOR THE MINERAL EXPLORATION GEOSCIENTIST by MICHAEL DENTITH & STEPHEN T MUDGE Published by Cambridge University Press: June 2014 ISBN 978-0-521-80951-1 438 pp.
List price: £45.00 www.cambridge.org/dentith

Geostatistical Reservoir Modelling

Realistic estimates of the size and productivity of any oil or gas asset are essential for reservoir management decisions and minimising economic risk. An important estimation process in such forecasting or comparison of different hydrocarbon recovery schemes and their economics is reservoir numerical modelling.

Reservoir models use the physically significant features that characterise the geologic, geochemical, and petrophysical controls of fluid flow. The needed data acquisition begins with field discovery through to the last phases of production and abandonment, but always direct knowledge of a reservoir is limited to a few drill-holes. In general, the large-scale features are most critical for the prediction of reservoir flow performance, and small-scale geological details summarised in effective properties at a larger scale. However all numerical models would be found in error if the inter-well volume were excavated and exhaustive measurements taken; there is always uncertainty.

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Reviewed by ***Richard Dawe***

GEOSTATISTICAL RESERVOIR MODELING - 2ND EDITION by MICHAEL J PYRCZ & CLAYTON V DEUTSCH Published by Oxford University Press, 2014, 433pp. ISBN 978-0-19-973144-2
List price: £64.00 hbk www.oup.com/uk

BOOKS Available for review

Please contact **ted.nield@geolsoc.org.uk** if you would like to supply a review. You will be invited to keep the review copy. See a full up-to-date list at **www.geolsoc.org.uk/reviews**

- **NEW! Energy, the subtle concept – the discovery of Feynman's blocks from Leibniz to Einstein** by Jennifer Coopersmith (revised) 2015 Oxford University press 422pp, sbk.
- **NEW! Fluid-induced seismicity,** by Serge Shapiro. Cambridge University Press 2015 276pp, hbk.
- **NEW! A photographic guide to Shetland's Geology** by David Malcolm and Robina Barton. Shetland Times Ltd., 2015.118pp, sbk
- **NEW! Soil physics with python - transport in the soil-plant-atmosphere system** by Bittelli, Campbell and Tomei. Oxford Unviersity Press 2015449pp, hbk
- **NEW! Precession, Nutation and Wobble of the Earth** by Dehant and Mathews 2015. Cambridge University Press, 536pp, hbk.

PEOPLE *NEWS*

CAROUSEL

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

◆Philip Donoghue

Professor of Palaeobiology in the University of Bristol's School of Earth Sciences, has been elected Fellow of the Royal Society. Described as 'major force in the emerging field of molecular palaeontology', his work 'bridges palaeobiology, developmental biology and molecular evolution. He first demonstrated the utility of synchrotron imaging in palaeontology and has been a world leader in driving forward our understanding of the remarkable fossil embryos from the late pre-Cambrian and Cambrian, and their biological significance.'

◆ Mark O'Neill

(PhD Geotechnical Engineering) has joined Earth Science Partnership to complement the partnership's skills and to drive business expansion, bringing additional civil engineering, geotechnical and major projects experience to their team. Mark's main experience was gained with global multi-disciplinary consultants, where he set up new geotechnical teams and led South West offices for Scott Wilson (now URS/AECOM), Buro Happold and subsequently as leader on geotechnical matters with Parsons Brinckerhoff.

◆ Patricia Pantos

has joined the Society's Publishing House as Production Editor on *Journal of the Geological Society* and a range of book titles. Patricia has a PhD in inorganic chemistry and has considerable experience in STM publishing having worked at both ecancermedicalscience and the Royal Society of Chemistry.

IN MEMORIAM WWW.GEOLSOC.ORG.UK/OBITUARIES

THE SOCIETY NOTES WITH SADNESS THE PASSING OF:

Barker, R W N *
Grinly, David *
Neiva, Joao Cotelo

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

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

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

◆ Hannah Sime

left the Geological Society at the end of March, and we wish her all the best for the future. After more than four years as Production Editor on JGS and a number of Society book titles, Hannah is leaving to dedicate her time to the family business, Really Decent Books.

◆ Tony Watts

Professor of Marine Geology and Geophysics at the University of Oxford, will deliver the 2015 Harold Jeffreys Lecture, given 'on the interior structure, formation and composition of the Earth and/or planets'. Previous Jeffreys lecturers have included this year's Wollaston Medallist James Jackson, and Wollaston Medallist Kurt Lambeck.

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

DISTANT THUNDER

Smith plaques – spot the errors!

Geologist and Science writer Nina Morgan* rights a few wrongs

On 22 March 2015 – the 246th anniversary of Smith's birth – a plaque was unveiled at the site of his birthplace in the village of Churchill, near Chipping Norton in Oxfordshire. The following day, another plaque was dedicated t 15 Buckingham Street, London, the site of the house that served as his base between 1804-1819. These new additions bring the total number of Smith monuments and plaques in the UK up to eight – and it turns out, serve to set the record straight. Each of the earlier six monuments contains errors.

A signpost memorial erected in at Rugborne Farm High Littleton Somerset, where Smith lodged 'for half a guinea a week, plus half a crown for his horse' while surveying the local coal mines states that Smith lived there from 1792-1795. He actually took up residence in October, 1791.

The plaque at Tucking Mill, near Midford outside of Bath (picture), which was designed to mark the house Smith purchased in 1798, is placed on the nearby and charmingly-styled Tucking Mill Cottage, rather than on the ashlar-faced and more austere Tucking Mill House, one side of which Smith actually owned. (Debates continue as to which side that was!)

A Bronze plaque at 29 Pulteney Street, Bath, the former residence of the Reverend Joseph Townsend [1739-1816], states that William Smith first dictated his list of the strata around Bath to Townsend and the Reverend Benjamin Richardson on 11 December 1799. But the event actually took place six months earlier, on June 11, 1799.

A plaque unveiled in 2009 on The Manor House, The Square, Stow on the Wold, Gloucestershire, marks the house where William Smith lived with his employer, the surveyor, Edward Webb, from 1787-1791. But it wrongly refers to Smith's pioneering map as a map of Britain, rather a map of England and Wales.

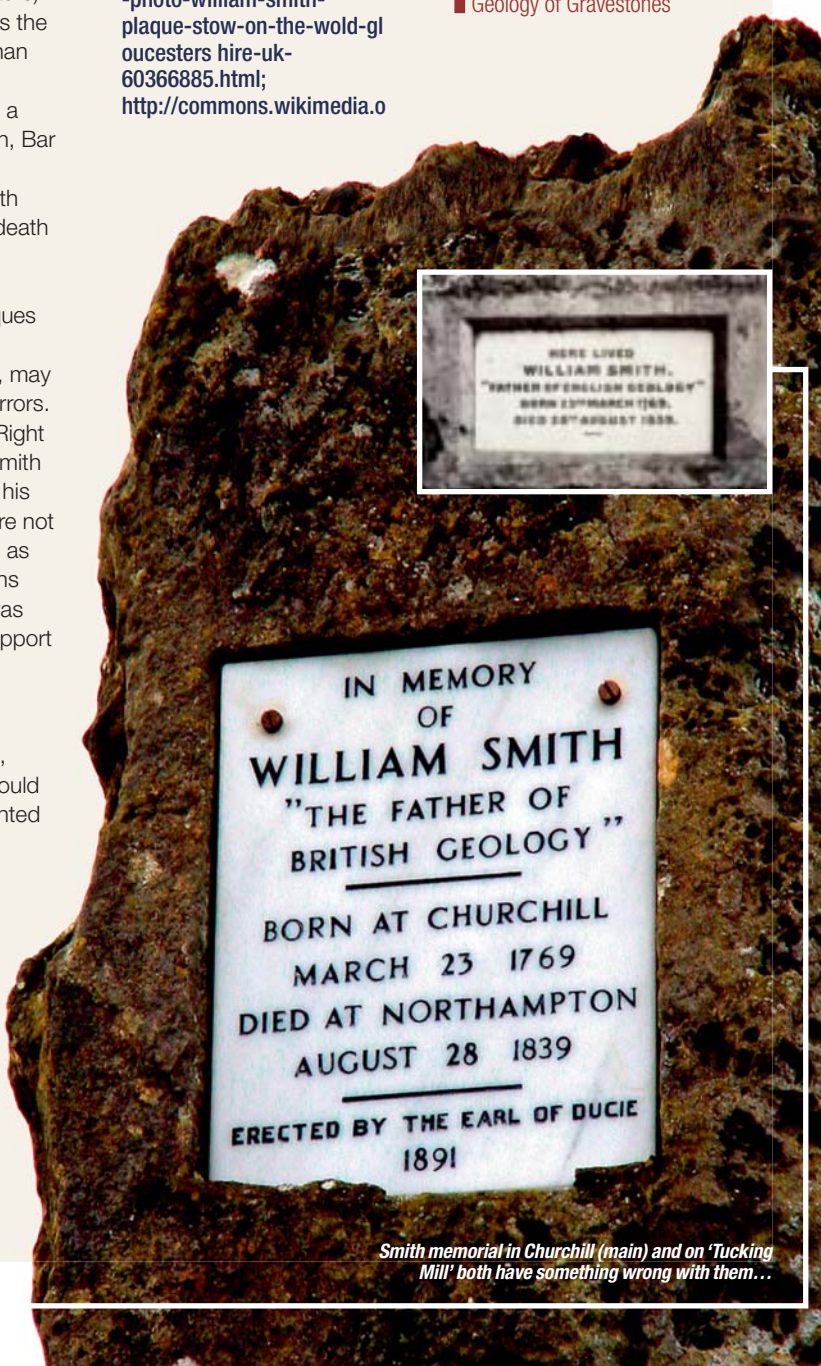
The monolith of local stone erected in Churchill in 1831 by the 3rd Earl of Ducie (picture) wrongly refers to Smith as the Father of British (rather than English) Geology.

A blue plaque hung on a building at 1 Newborough, Bar Street Elevation in Scarborough, where Smith lived from 1835 until his death in 1839, is placed on the wrong building.

The details on the plaques may suffer from some inaccuracies – as indeed, may my own account of the errors. But one thing is certain. Right up to the end of his life Smith continued to believe that his work and discoveries were not fully appreciated. As late as June 1838, just 14 months before he died – Smith was drafting an Appeal for Support entitled "The case of the Founder of Geology." So when it comes to the plaques and monuments, accurate or not, Smith would certainly have been delighted with the recognition!

Acknowledgement
This vignette was inspired by a speech given by Hugh Torrens as he unveiled the new William Smith plaque on the site of Smith's former home in Churchill, Oxfordshire. Hugh also provided information about the earlier plaques and monuments mentioned – but any mistakes in the descriptions of the errors are mine alone! Other sources of information include: The Case of the Founder of Geology, part of a manuscript written by Smith in 1838 house in the Smith collection at the Hope Library at the Oxford University Museum of Natural History; the websites: **http://bath-heritage.co.uk/smith_william.html; http://openplaques.org/plaques/1672; http://www.alamy.com/stock-photo-wiiliam-smith-plaque-stow-on-the-wold-gloucesters hire-uk-60366885.html; http://commons.wikimedia.org/wiki/File:Tucking_Mill_Cottage,_Midford_-_plaque_-_geograph.org.uk_-_422748.jpg**; Cox, L.R, 1951, A signpost memorial to William Smith by L.R. Cox, Geol. Mag, 88/6, p. 441; Eyles, Joan M, 1969, William Smith (1769-1839) A Chronology of Significant Dates in His Life, Proc. Geol. Soc. London, 1657, pp. 173-176.

***Nina Morgan** geologist and writer based in Oxford, currently working on a book about the Geology of Gravestones



Smith memorial in Churchill (main) and on 'Tucking Mill' both have something wrong with them…

OBITUARY MARTIN DAVID BRASIER 1947-2014

Palaeontologist who specialized in the emergence of multi-celled life during the Cambrian 'explosion'

Martin Brasier, one the UK's leading palaeobiologists, who tragically died in a car accident on 16 December 2014, was highly regarded for his research into key junctures in Earth's early life, from Archaean origins to the emergence of multi-celled animals during the Cambrian explosion. Martin was Emeritus Professor of Palaeobiology, Department of Earth Sciences, University of Oxford, from where he had retired at the end of the previous academic year.

Born 12 April 1947, he took a degree at Chelsea College London, and was awarded his PhD from University College London in 1973, studying the ecology and microhabitats of modern Caribbean benthic foraminifera. Following brief employment with BGS and a lectureship at Reading University, he moved to Hull, developing an interest in the taphonomy and diversity of lower Cambrian small shelly fossils.

In the early 1980s, with colleague John Neale, he established a Masters Course in micropalaeontology. This coincided with the publication of *Microfossils*, which appeared in a second edition (with Howard Armstrong) in 2004. His study of foraminiferal architecture and evolution was published in a special publication (1982) honouring the work of Tom Barnard, Martin's PhD supervisor.

During the 1970s Martin contributed to the British Micropalaeontological Society, serving as Foraminifera Group Secretary (1974-77), BMS Newsletter Editor (1977-79) and Foraminifera Group Chair (1983-85). In 1981 he was co-editor (with Neale) of the book *Microfossils from Recent and Fossil Shelf Seas*.

Palaeobiology

Martin moved to Oxford in 1988, was elected Fellow of St Edmund Hall, and helped establish a dedicated palaeobiology research laboratory. He pursued high-resolution contextual analysis of Ediacaran and Cambrian evolutionary radiations, and took a leading role in the International Geological Correlation Programme (IGCP), visiting Cambrian and Ediacaran stratotype sections.

> MARTIN HELPED REVOLUTIONISE THE STUDY OF THE EARLIEST BIOSPHERE, PIONEERING A NEW, CRITICAL APPROACH

During the next 15 years Martin helped revolutionise the study of the earliest biosphere, pioneering a new, critical approach in assessing the biogenicity of Earth's most ancient traces of life. In April 2002, at the NASA Ames conference in San Francisco, he debated the origins of the 3460Ma putative microfossils from the Apex chert deposit of Western Australia. Martin championed the approach of careful mapping at various scales, utilising features and fabrics from field observations and petrographic sections in interpreting the micro-fabrics – an approach that yielded a high scientific return in publications, and which he frequently referred to as his most satisfying research project.

Lyell Medal

Martin's ability for storytelling was put to great effect in his popular science books *Darwin's Lost World (2009)* and *Secret Chambers (2013)*. In early 2014 Martin's contributions were formally recognised by the award of the Society's Lyell Medal (picture, left). Later that year, on his retirement, a day of talks in the department was followed by a dinner at St Edmund Hall. The diversity of attendees indicated the wide influence he enjoyed, and the warmth with which he was regarded.

Martin has left us with a substantial legacy of over 200 published papers and books. He was also a skilled jazz pianist, and built some of his own keyboard instruments. He is survived by Cecilia, his wife of more than 40 years, sons Matthew and Alexander, daughter Zoe and two grandchildren.

By **Owen Green**

These obituaries have been edited from longer versions, available online

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

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

ENDORSED TRAINING/CPD

COURSE	DATE	VENUE AND DETAILS
Introduction to Micromine	14-15 July	Venue: Challoner House, 19 Clerkenwell Close, London EC1R 0RR. Time: 0930-1730. Cost: £110. See website. Contact: Jenny York E: mmuk@micromine.com
Resource Estimation in Micromine	16-17 July	Venue: Challoner House, 19 Clerkenwell Close, London EC1R 0RR. Time: 0930-1730. Cost: £500. See website. Contact: Jenny York E: mmuk@micromine.com
The Geoscience Education Academy	23-26 July	Free Training for UK teachers. Venue: Burlington House. Free including travel & accommodation. For registration and details see www.geolsoc.org.uk/gea
Lapworth's Logs	n/a	'Lapworth's Logs' is a series of e-courses involving practical exercises of increasing complexity. Contact: info@lapworthslogs.com. Lapworth's Logs is produced by Michael de Freitas and Andrew Thompson.

EVENTS

COURSE	DATE	VENUE AND DETAILS
Abberley & Malvern Hills Geopark - GEOFEST	July, August	Wide range of activities in the Geopark continues through July and August. For programme W: http://bit.ly/1HL9F2L
William Smith Lecture, Geologists' Association	3 July	Lecture on William Smith. Speaker: Tom Sharpe. As part of regular Friday Evening Lecture Series. Venue: Burlington House. E: geol.assoc@btinternet.com
Euroclay 2015, The Clay Minerals Society, The Mineralogical Society Clay Minerals Group, 2015 Year of Mud	5-10 July	Conference. Venue: Edinburgh University, Appleton Tower, Edinburgh. See website for details and registration. W: www.euroclay2015.org/
Shale Gas and Integrated Water Management Conference, CIWEM	7 July	Conference. Venue: SOAS, University of London. See website for details and registration. Contact: events@ciwem.org. W: http://bit.ly/1cZc3lp
Early Career Hydrogeologists' Conference 2015, Hydrogeology Group	8-9 July	CPD Approved conference and field visit. Venue: Newcastle University. See website for registration & details. Fees apply. Contact Chris Jackson E: crja@bgs.ac.uk.
Groundwater: Our Hidden Asset - Recent developments in hydrogeology Hydrogeology Group	8 July	Dick Downing memorial meeting. Venue: Burlington House. Fees apply – see website for details & registration. Contact Paul Howlett E: paul.howlett@rhdhv.com
'The Geologists' House', Geol. Soc. Library, William Smith event	9 July	Venue: Geological Society Library, Burlington House, from 1830. A social event and evening meeting. For details and essential pre-booking, see website. Contact E: library@geolsoc.org.uk
Geophysics for Critical Infrastructure Engineering Group; Near Surface Geophysics Group	16 July	Venue: BGS, Keyworth. Conference for industry professionals. See website for details. Contact: EGGS E: engineering.group@geolsoc.org.uk
Shetland Fieldtrip, Metamorphic Studies	17-23 July	Venue: Shetland Islands. Registration officially closed in April. Contact: Clare Warren E: clare.warren@open.ac.uk

OBITUARY ROY FAVELL KING 1925-2014

Pioneer of applied geomagnetism, whose research in Wales pointed to Mochras discoveries

Roy King (b. 14 August 1925) became a geophysicist in the early 1950s. King took a first in Physics at Cambridge followed by a PhD on friction, with David Tabor. But he was ready for a change from laboratory physics and was glad to accept an invitation from Donald Griffiths, a geologist, to join him on an expedition to collect varved clays in northern Sweden.

After the expedition, King was awarded an ICI Fellowship at Birmingham to do experimental and fieldwork on varves with Griffiths. In 1955 he was appointed Lecturer in a new sub-department of geophysics to start one of the first two 12-month taught MSc courses in the UK to meet the growing demands of the oil, mining, and engineering industries.

The work on varves was continued with a succession of students and led to ways of correcting for the deviations of the magnetisation directions from the field directions.

The partnership also developed new teaching and research interests in Wales which concentrated for several years on following up a regional gravity survey by D W Powell, one of Griffiths' early students.

Mochras

Fieldwork – while camping or living in makeshift accommodation – was very much to King's taste. For several years it concentrated on a large fault discovered by Powell bordering the Cambrian rocks along the coastline near Harlech. This seemed to indicate a hitherto unsuspected sequence of younger rocks beneath Cardigan Bay. King took charge of refraction seismic work to study the stratigraphy of this basin and was able to verify its existence and to estimate its thickness and likely origin.

This work, together with his course teaching in seismology, led to the second main thread of his research career. His later investigations included two landmark long-range profiles: the Kenya Rift International Seismic Profiles (KRISP) 1967-90; and the 1981 north-south Lithospheric Seismic Profile of Britain (LISPB). But he also pioneered the development of short-range reflection and refraction measurements applicable to civil engineering and hydro geological problems.

> “FIELDWORK ON A FAULT BORDERING THE COAST NEAR HARLECH INDICATED YOUNGER ROCKS BENEATH CARDIGAN BAY”

King and Griffiths became lifelong partners in teaching and research. The two editions of their text-book *Applied Geophysics for Geologists and Engineers* were popular with practitioners and students. They became great friends and, when King married Sheila Griffiths (d. 1977), became brothers in law.

King claimed to dislike administration though he was adept at organising his own work and that of his collaborators. He retired in 1990 as Reader in Geophysics, a fitting recognition of his academic status and the way he chose to work.

Fluent

In addition to hill walking, often in the company of his extended family, he enjoyed music, literature, travelling, and political discussion. He became fluent in German. In his last years he also learned Italian so as to best enjoy his visits to his daughter and her family in Verona.

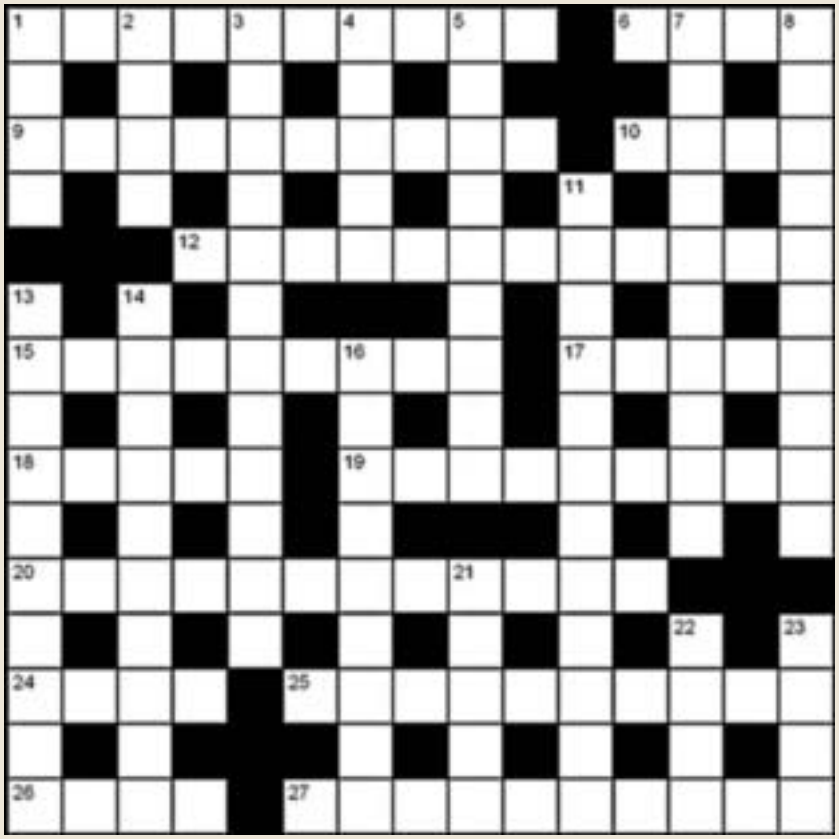
Despite an increasingly frail appearance he remained active until he was struck by a sudden acute, and eventually fatal infection shortly after his 89th birthday (d. 20 August 2014). His two children, John and Kirsten, and four grandchildren survive him.

By **Anthony Rees, Aftab Khan**

These obituaries have been edited from longer versions, available online

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

CROSSWORD NO.193 SET BY PLATYPUS



ACROSS

1 Soil-creep induced, step-like formation on steep grassland slopes (10)
6 Former Thailand (4)
9 Chopsy brachiopod? (10)
10 Softest mineral known to Mohs (4)
12 Brought back to fleshly existence (12)
14 Incorruptible metal (4)
15 Any problem solving approach that uses practical, sufficient but sub-optimal methods (9)
17 Dose of salts may explain why horses run fast (5)
18 From coronation to death or abdication (5)
19 Symbol or emblem of position, status or power (9)
20 Scientist who does not trouble himself with experiment (12)
24 Long pole bearing, for example, a microphone (4)
25 Vulgar and scandalous, usually of journalism (10)
26 Not the compass point of Krakatoa from Java, despite what the film title says (4)
27 Stargazing mystic (10)

DOWN

1 Step-like topography created by successive eruptions of flood basalt (4)
2 Ratio in which two measurements are related to one another (4)
3 '- wedge' or '- prism' of sediment that becomes attached to a non-subducting plate (12)
4 TV Sitcom by eponymous American comedienne, host, actress, writer and producer, which ran from 1994 to 1998 (5)
5 The four people in whom power is invested in a particular form of government associated with Diocletian from AD203 - and the Geological Society of London. (9)
7 Characteristic of the creative product of the talentless unskilled (10)
8 To treat a road surface according to the precepts of John Loudon McAdam (10)
11 Warm period between ice advances (12)
13 Given to acts of kindness (10)
14 Gold-bearing (10)
16 Combination of three panelled pictures, as behind an altar for example (9)
21 Boring implement that produces a cylinder of penetrated material (5)
22 Medal, jocularly (4)
23 European slavic monarch (4)

WIN A SPECIAL PUBLICATION!

The winner of the May Crossword puzzle prize draw was Gordon Scott of Kuala Lumpur, Malaysia.

All correct solutions will be placed in the draw, and the winner's name printed in the Issue 2014 issue. The Editor's decision is final and no correspondence will be entered into. **Closing date - 20 July.**

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

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

Name .....

.....

Membership number .....

Address for correspondence .....

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Postcode .....

SOLUTIONS MAY

ACROSS:
1 Anthracite **4** Able **9** Brontosaur **10** MORB **12** Vindictively **15** Slingshot **17** Steel **18** Elgon **19** Badgering **20** Tangentially **24** Sass **25** Abominable **26** So So **28** Perthshire

DOWN:
1 ASBO **2** Troy **3** Rotliegende **4** Cased **5** Truncated **7** Biogenesis **8** Embryology **11** Misspellings **13** Asbestosis **14** Biogenesis **16** Habitable **21** Admit **22** Abri **23** Gene


The Geological Society
serving science & profession
Call for Abstracts – Extended Deadline 31 August 2015
European Oil & Gas Industry History conference
3-4 March 2016
Burlington House, Piccadilly, London
This joint conference between the Petroleum Group of the Geological Society, the History of Geology Group of the Geological Society and the Petroleum History Institute will be held in London in March 2016. It will mark several important anniversaries including 150 years of oil exploration in Poland & Romania, the centenary of the drilling of the first oil well in the UK, and 50 years of oil production onshore Spain. The focus of the conference will be to examine the history and heritage of the oil and gas industry in Europe from the earliest onshore drilling (and digging) to its development into the industry that we know today and also to examine the transition from conventional to unconventional resource plays in the onshore arena.
Associated Events:
A fieldtrip will be arranged over the weekend following the conference to examine the history, industrial archaeology and geology of the UK's earliest oil and gas fields in the east Midlands and the Peak District. During the trip a memorial plaque and information board will be unveiled at the Hardstoft-1 well site in Derbyshire, marking the 100th Anniversary of the drilling of the well under the defense of the Realm Act to reduce Britain's dependence on oil imports.
Call for Abstracts:
Please email paper and poster contributions to laura.griffiths@geolsoc.org.uk and copy to fiona@rockhopperexploration.co.uk by 31st August 2015.
For further information please contact:
Laura Griffiths: The Geological Society, Burlington House, Piccadilly, London W1J 0BG. T: 020 7432 0960 or email: laura.griffiths@geolsoc.org.uk
At the forefront of petroleum geoscience
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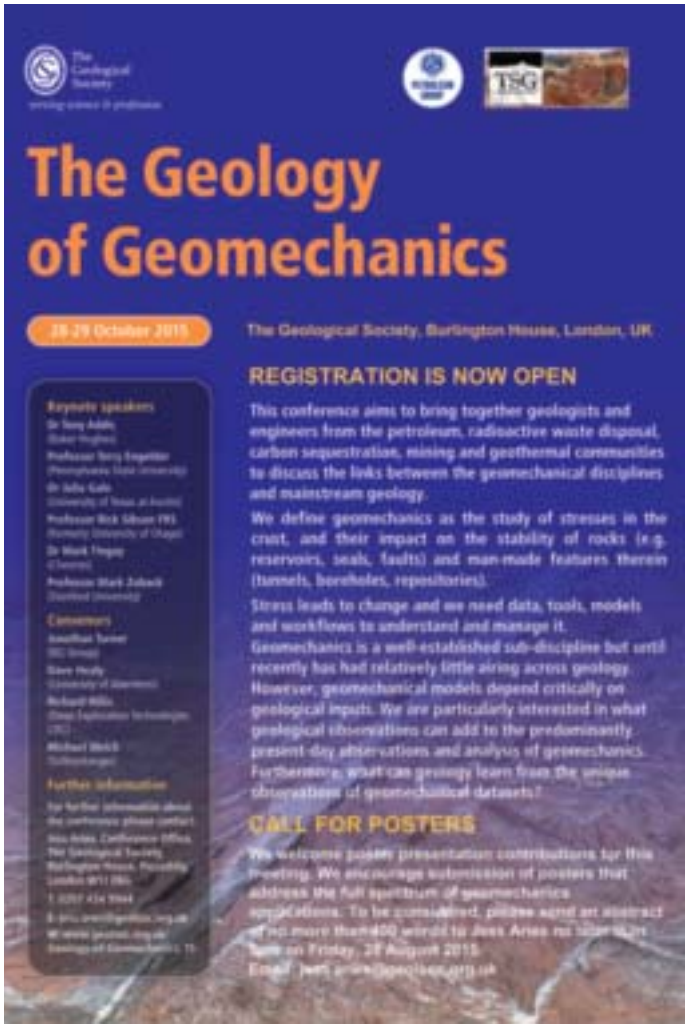
YEAR OF MUD
Geomechanical and Petrophysical Properties of Mudrocks
16-17 November 2015
The Geological Society, Burlington House, London
REGISTRATION IS NOW OPEN
A surge of interest in the geomechanics and petrophysical properties of mudrocks (shales) has taken place in recent years following upon the development of a shale gas industry in the United States and with the prospect of similar developments in the UK and elsewhere. Compared to most other rock types, geomechanical and microstructural studies on mudstones are more demanding owing to their fine grain size, complex mineralogy and difficulties in handling. The need to develop an industry that is efficient and satisfies public concerns demands that the fullest possible understanding of the mechanical and petrophysical behaviour of these rocks be obtained and applied to engineering and environmental questions.
The scope of this meeting encompasses studies of strength and frictional behaviour, time-dependent creep, hydraulic fracture development, permeability, electrical conductivity and acoustic wave propagation.
Call for Posters
We welcome both poster presentation contributions for this meeting. If you would like us to consider you for a poster presentation for this meeting, please send an abstract of no more than 400 words to Jess Aries no later than Friday 18 September 2015.


The Geological Society
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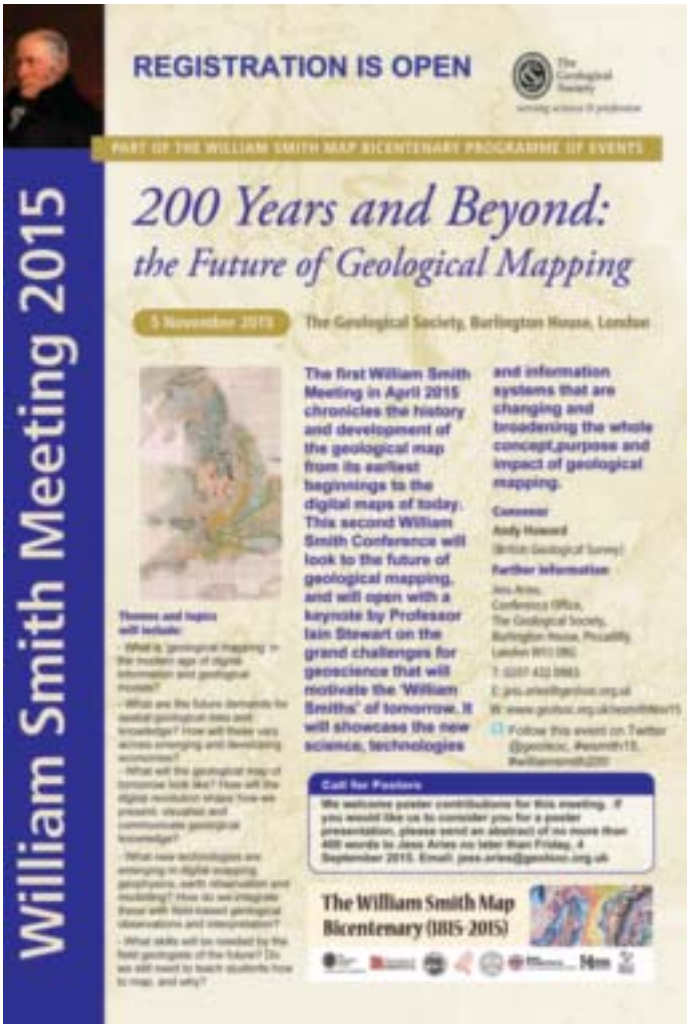
TSG
The Geology of Geomechanics
28-29 October 2015
The Geological Society, Burlington House, London, UK
REGISTRATION IS NOW OPEN
This conference aims to bring together geologists and engineers from the petroleum, radioactive waste disposal, carbon sequestration, mining and geothermal communities to discuss the links between the geomechanical disciplines and mainstream geology.
We define geomechanics as the study of stresses in the crust, and their impact on the stability of rocks (e.g. reservoirs, seals, faults) and man-made features therein (tunnels, boreholes, repositories).
Stress leads to change and we need data, tools, models and workflows to understand and manage it. Geomechanics is a well-established sub-discipline but until recently has had relatively little airing across geology. However, geomechanical models depend critically on geological inputs. We are particularly interested in what geological observations can add to the predominantly present-day observations and analysis of geomechanics. Furthermore, what can geology learn from the unique observations of geomechanical datasets?
CALL FOR POSTERS


REGISTRATION IS OPEN
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PART OF THE WILLIAM SMITH MAP BICENTENARY PROGRAMME OF EVENTS
William Smith Meeting 2015
200 Years and Beyond:
the Future of Geological Mapping
5 November 2015
The Geological Society, Burlington House, London
The first William Smith Meeting in April 2015 chronicles the history and development of the geological map from its earliest beginnings to the digital maps of today. This second William Smith Conference will look to the future of geological mapping, and will open with a keynote by Professor Iain Stewart on the grand challenges for geoscience that will motivate the 'William Smiths' of tomorrow. It will showcase the new science, technologies and information systems that are changing and broadening the whole concept,purpose and impact of geological mapping.
Call for Posters
The William Smith Map Bicentenary (1815-2015)

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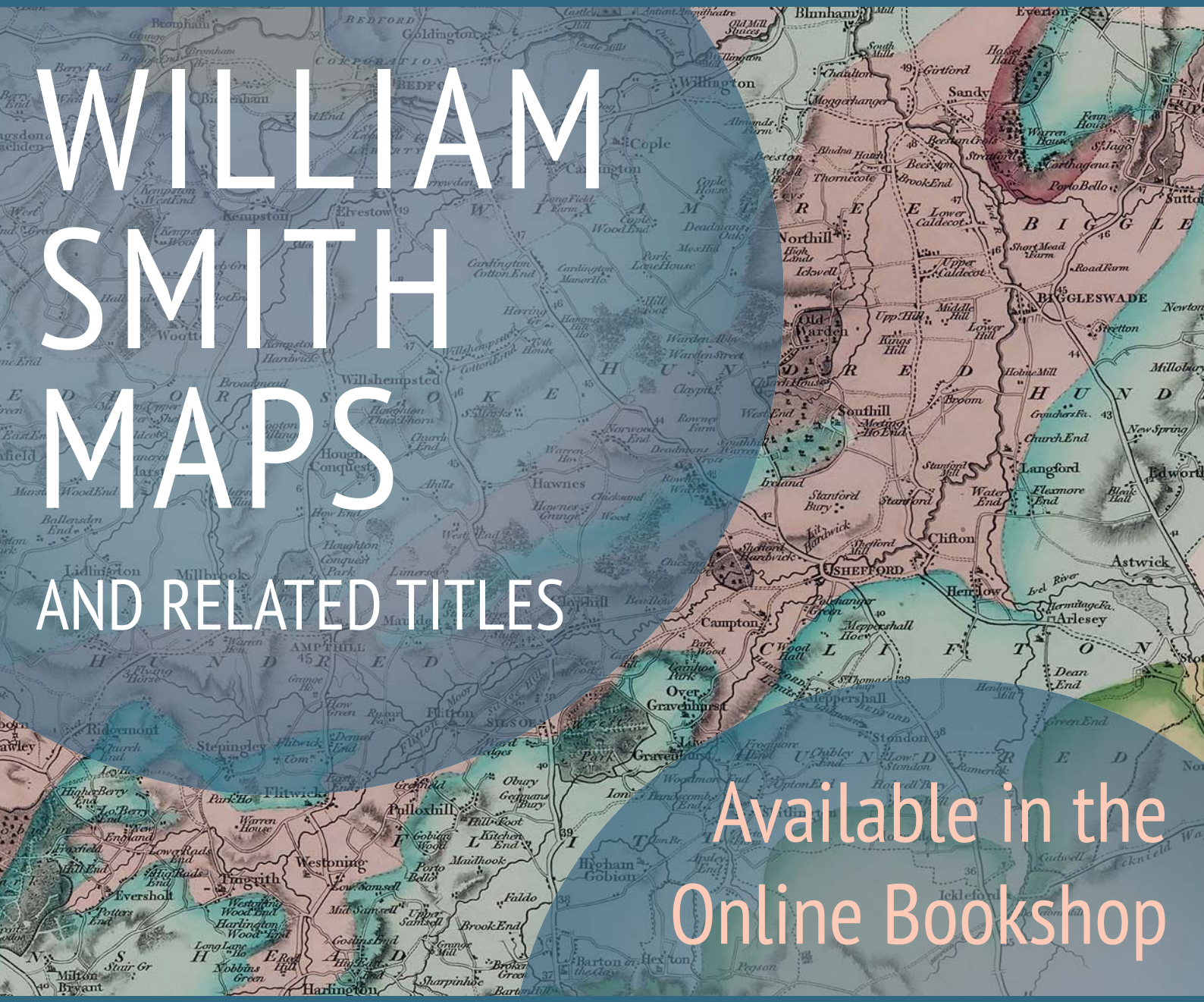

WILLIAM SMITH MAPS

AND RELATED TITLES

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Background image: William Smith Geological Map of Bedfordshire, 1820