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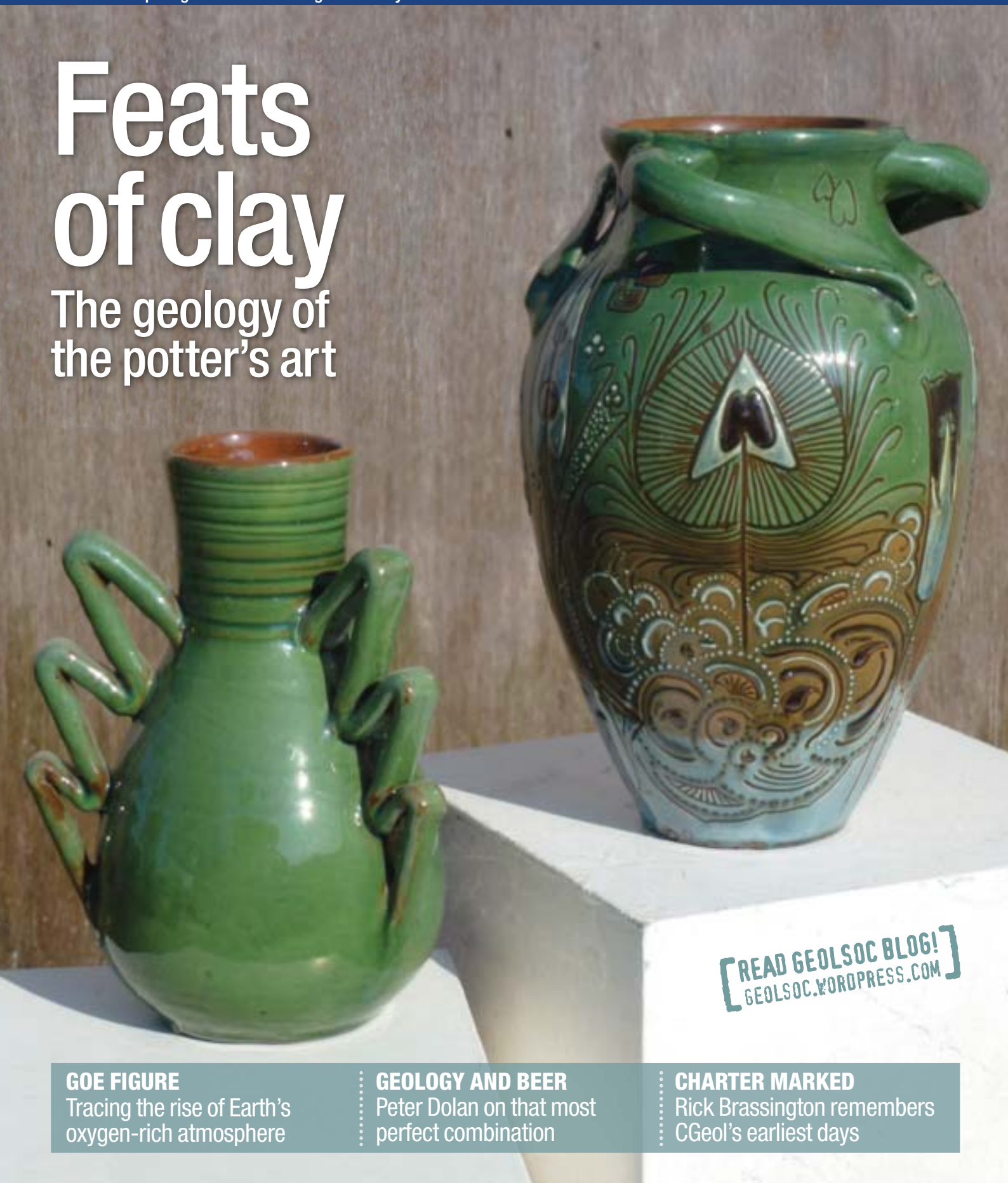

Feats of clay

The geology of the potter's art

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GOE FIGURE
Tracing the rise of Earth's oxygen-rich atmosphere

GEOLOGY AND BEER
Peter Dolan on that most perfect combination

CHARTER MARKED
Rick Brassington remembers CGeol's earliest days

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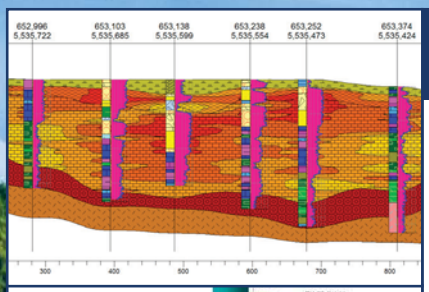

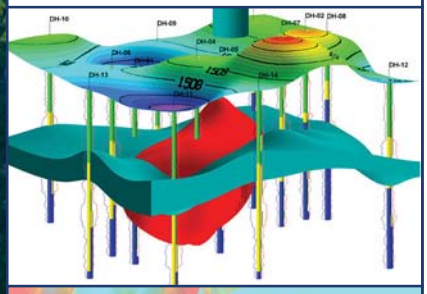

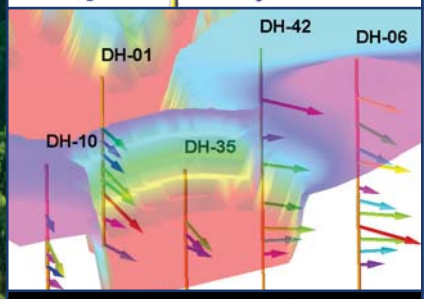

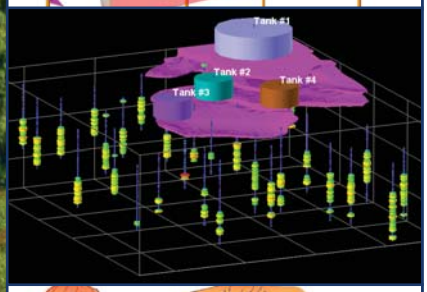

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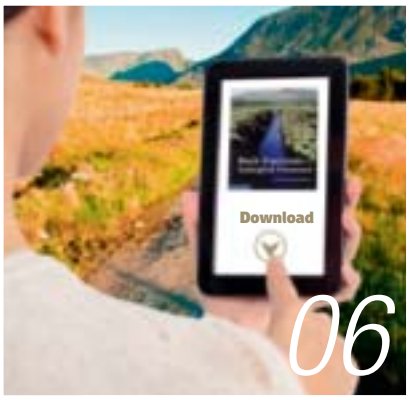

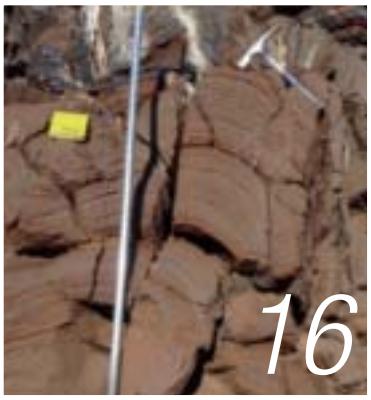

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ON THE COVER:

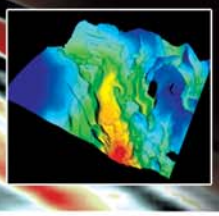
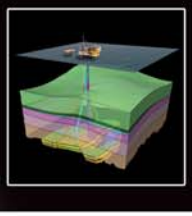
10 Working with clay

When John Mather retired, he decided to learn how to make the ceramics that he and Jenny Bennett had always collected...

ONLINE SPECIALS **Geology and Beer**
Peter Dolan stares into the glass and finds it overflowing with geological meaning.

FEATURES

REGULARS

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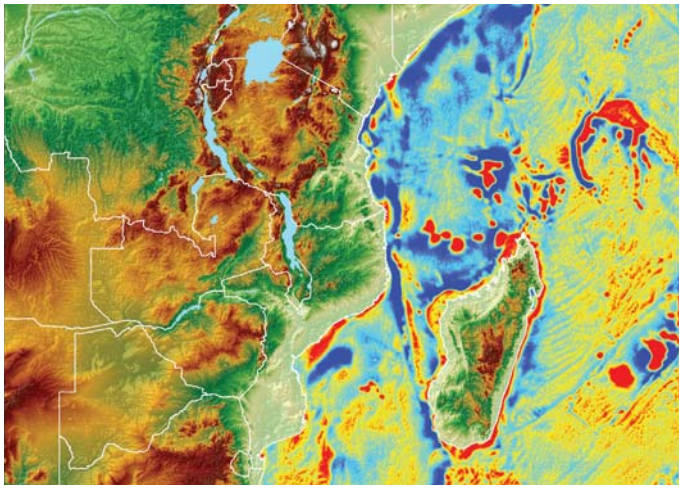
Call for Abstracts – Deadline 31 July 2015

East Africa
From Research to Reserves

13-15 April 2016

The Geological Society, Burlington House, Piccadilly, London

Image courtesy of CCG



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

Papers are invited that reflect the step change in geological understanding of the region that has evolved from new well and seismic data, to cover topics including: the regional geological context, emerging exploration plays, case study scenarios for reservoir characterization and leveraging academic research to improve understanding across all these themes.

The meeting will bring together experts from industry and academia to present the latest data and research

Call for Abstracts:

Please email paper and poster abstract submissions to laura.griffiths@geolsoc.org.uk before 31 July 2015

Further information:

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

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TWO VASES FROM THE BARNSTAPLE POTTERY OF C.H. BRANNAM, MADE USING BROWN CLAY FROM FREMINGTON AND COLOURED SLIPS. THE LARGER VESSEL WAS DECORATED IN THE ART NOUVEAU STYLE BY FREDERICK BRADDON, DATED 1907

Front: From the collection of Jenny Bennett and John Mather

FROM THE EDITOR'S DESK:

Brontosaurus is back

In the second month of the new Millennium, the American Museum of Natural History opened the Frederick Phineas and Sandra Priest Rose Centre for Earth and Space – a name designed to defy the human memory, and so called simply the 'Rose Centre'. It contained the better-known Hayden Planetarium, where redesigned exhibits displayed the solar system in a new way. And it wasn't long before its Director – one shy, retiring Neil deGrasse Tyson – had become the bad guy of astronomy for millions of American eight-year-olds.

The exhibit displayed the components of the solar system in groups with like properties – rocky planets, gas giants, and so on. This left one of the best-known planets – Pluto, the only one to be discovered by an American (Clyde Tombaugh in 1930) – out in the cold among other icy, trans-Neptunian objects, un-named.

Every child's question - *'Mommy, where's Pluto? '*- eventually reached the pages of the New York Times. Neil deGrasse Tyson began a gruelling five years of self-defence - until 2006, when the International Astronomical Union formally downgraded Pluto to the status of 'dwarf planet' at its triennial assembly in Prague. This may have taken pressure off AMNH, but outrage continued. Something that everyone *thought* they knew, was no longer true.

Much the same fate befell *Brontosaurus*. Everybody knew about *Brontosaurus*, from Fred Flintstone's Brontoburgers, to the appealing fact that its name (given in 1879 by Othniel C Marsh himself) meant 'Thunder Lizard'. And it came as a nasty shock to everyone to discover that poor old genus *B.* had been sunk since as early as 1903, when palaeontologist Elmer Riggs determined (or so he thought) that *B.* was merely a junior synonym of another Marsh genus, *Apatosaurus* (1877). Almost every generation since then has felt outrage that their favourite diplodocid never actually existed.

However, a monumental new taxonomic study (truly a *Brontosaurus* of the genre at 300 pages published April 7, in *PeerJ*) has determined that no less than three species of the genus – *excelsus* (the first discovered) *parvus* and *yahnahpin* – were real, after all. There has already been media rejoicing, and the kiddies' books that reluctantly had to deny themselves one of the best-known dinosaur names of all, can now be re-written.

With continued popular opposition to the demotion of Pluto, and even some scientists (also in April) urging a recasting of IAU's rules to allow it back, perhaps we should remember that science has always had something in common with online journalism. Its motto, too, can sometimes be 'Not wrong for long'.

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

Honorary Fellowship

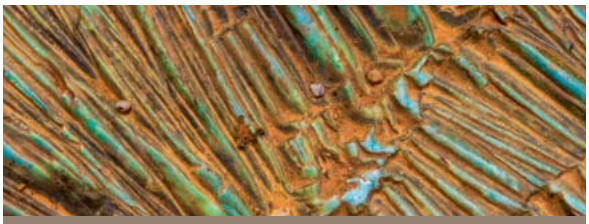
Following a proposal from the External Relations Committee, Council recommends the following candidate for election to Honorary Fellowship at a future Ordinary General Meeting.

Dr Gabi Schneider

Dr Schneider graduated in 1980 with a Master of Science in Economic Geology from the University of Frankfurt, where she also obtained her PhD in 1984. She joined the Geological Survey of Namibia in 1985 as a Senior Geologist and was appointed Director in 1996. Her professional experience covers economic and exploration geology, mineralogy and geochemistry as well as management and administration. She is an honorary life member of the Geological Society of Namibia, and is a registered Scientist with the South Africa Council for Natural Scientists.

Dr Schneider is the President of the Organisation of African Geological Surveys (2013-2016) and the Vice Chairperson of the Environmental Investment Fund of Namibia; a Director of the Minerals Development Fund of Namibia; the Vice Chairperson of the Board of Trustees of the Namibian Institute for Mining and Technology; a member of the Sustainable Development Council of Namibia; a member of the Benguela Current Commission; a member of the Commission for the Implementation of the World Heritage Convention in Namibia, chairing its Technical Subcommittee; and a member of the Scientific Committee of the National Heritage Council. She is a founding member of the Small Miners Association of Namibia.

Dr Schneider is a member of the Natural Science Programme Committee of the Namibian National Committee for UNESCO, and a Senior Advisor for UNESCO's Geopark Programme. She represents the African continent at the International Consortium of Geological Surveys. She is chairing the Geology Advisory Board of the University of Namibia, and has been an external examiner of the University of St. Andrews, the University of Frankfurt, the University of the Witwatersrand and University of South Africa.



LONDON LECTURE SERIES

Fossils and Mud – a Jurassic Adventure

Speaker: Dr Neville Hollingworth (University of Birmingham) **Date:** 10 June

Programme

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

Further Information

Please visit **www.geolsoc.org.uk/gsllondonlectures15**. Entry to each lecture is by ticket only. To obtain a ticket please contact the Society around four weeks before the talk. Due to the popularity of this lecture series, tickets are allocated in a monthly ballot and cannot be guaranteed.

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

STEPPE this way

Society joins a new consortium to promote research, *writes Sarah Day.*

At the beginning of this year, the Geological Society was pleased to become a member of STEPPE – a consortium promoting research into sedimentary geology, time, environment, palaeontology, palaeoclimate and energy.

STEPPE's mission is to promote multidisciplinary research and education on Earth's deep-time sedimentary crust, and the record of life and climate it archives. It provides support to the scientific community by highlighting funding opportunities, providing opportunities for workshops, working groups and professional development training sessions, and web hosting and database services.

STEPPE is supported by the US National Science Foundation and professional societies, representing a community which includes roughly one third of Earth science faculty in US universities. The size of this community and the diverse range of disciplines it covers – biology, geography, ecology, palaeontology, sedimentary geology, stratigraphy, geochronology, paleoclimatology, sedimentary geochemistry and more – means communication among participants can be a challenge. By providing tools to bring participants closer together, STEPPE is working to promote broader integration of research and education across all STEPPE-related sub disciplines.

Edmund Nickless (Executive Secretary) said: "As the newest member of STEPPE, the Society looks forward to pursuing shared goals of promoting geoscience research, education and professional development."

Find out more about STEPPE's mission and its members at **www.steppe.org**; Facebook: **www.facebook.com/deeptimerocks**; and Twitter: **www.twitter.com/deeptimerocks**.

Research Grants 2015

The Research Grants Committee met on 12 March and considered 41 applications from Fellows and non-Fellows spanning early-career and established researchers. They recommended to Council that £28,330 be awarded to 21 applicants, which Council approved at their 8 April meeting. The Society is very grateful for the contributions made by the Jeremy Willson Charitable Trust, the Robert Scott Memorial Award and Novas Consulting Ltd.

COUNCIL RESULTS

Name and Affiliation	Title of programme	Fund	Amount
Claire BULLAR **Bristol**	Braincase anatomy and phylogeny of ceratopsians from Asia	William George Fearnsides	2798
Stacy CAROLIN **Oxford**	Rainwater monitoring in Iran to improve climate interpretations from stalagmite records	Elspeth Matthews	1009
Katy CHAMBERLAIN **Durham**	A tale of two magmas: investigating zoned pyroclastic airfall deposits on Ascension Island	Gloyne Outdoor Geological Research	3778
Nahum CLEMENTS **Cambridge**	A new generation of gas sensors to quantify geologic CO_2 emissions: application to Campi Flegrei, Italy	Alan & Charlotte Welch Fund	1150
Sam Cornish **Oxford**	Excavating eclogites from beneath the Oman Ophiolite	Annie Greenly	870
Michael DUNK **Portsmouth**	A modern isotopic appraisal of the Strathy Complex: a unique juvenile crustal block in the northern Scottish Caledonides?	William George Fearnsides	500
Miguel GOMEZ-HERAS **Ciencia sin Barreras**	Field-based geology teaching for people with deaf-blindness in the Basque Coast Geopark (Spain)	Jeremy Willson Charitable Trust & Thomas Jefferson Field Research	Euros 1540 (£1144)
Enrique GOMEZ-RIVAS **Aberdeen**	Controls on fault-associated dolomitisation geometries: insights from 3D virtual outcrop models and high-resolution petrography	Elspeth Matthews Fund	1550
Christopher HERBERT **UEA**	Unit bar formation and structure in a highly variable fluvial regime	Edmund Johnson Garwood Fund	800
Gareth James IZON **St Andrews**	The control of Nickel fluxes on atmospheric chemistry before the GOE	Alan & Charlotte Welch Fund	1613
Amicia Elizabeth LEE **Leeds**	A field based and numerical study to investigate how the seismic properties change with melt and fluid in the mid to lower crust	Thomas Jefferson Field Research	2775 (2 people)
Alistair McCAY **Glasgow**	Identification of geothermal energy targets in the East Grampian radiothermal granites	Alan & Charlotte Welch Fund	1170
Nicolette MEYER **St Andrews**	Multiple Sulphur Isotope Studies of Pyritised Microbially induced sedimentary structures, Neoarchaean Ghaap Group, South Africa	Alan & Charlotte Welch Fund	1200
Huw Thomas MITHAN **Cardiff**	Quantifying the dynamic response of permafrost and slope stability in a changing climate	Robert Scott Memorial Award	1032
Josefine Agnes Maria NANNE **Durham**	The stable osmium isotope composition of chondrites	Alan & Charlotte Welch Fund	1000
Jonathan David PAUL **Cambridge**	Independent constraints on Madagascar's uplift history	Daniel Pidgeon Fund	1115
Lorenzo VALETTI **Manchester**	Detachment faulting in the s-e Sorbas basin, SE Spain	Mike Coward Memorial Fund	1146
Marijn van CAPPELLE and Daniel COLLINS **Imperial**	The origin of kilometre-thick sandstone-dominated successions in the Late Precambrian: a sedimentological analysis of theJura Quartzite, SW Scotland	Annie Greenly Fund	330
Daniel Ricardo VIETE **Durham**	Exploring the links among earthquakes, fluid flow and rapid metamorphism in subduction zones	Elspeth Matthews Fund	1000
Brigitte VOGT **Strathclyde**	Multi scale geometries and the origin of the pseudotachylytes in the Outer Hebrides – earthquake, impact or intrusion?	Mike Coward Memorial Fund	1400
Lee Francis WHITE **Portsmouth**	A man-made meteorite impact: examining the response of U-Pb geochronometers to experimental shock conditions	Daniel Pidgeon Fund	950
Undergraduate Fieldwork Bursary			
Eireann HARKINS **Aberdeen**	A 3-dimensional analysis and architecture of the lava flow drainage basin in South-West Mull	Novas Consulting Ltd	500

NEWS IN BRIEF

Future meeting dates

➤ OGMs: 2015: 17 June, 22 September, 25 November. 2016: 3 February, 6 April

➤ Council: 17 June, 22 and 23 September (residential), 25 November. 2016: 3 February, 6 April.

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. (The Founders' Dinner, in November, has its own price structure.) There is a cash bar for the purchase of aperitifs and wine.

2015: New session dates to follow.

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

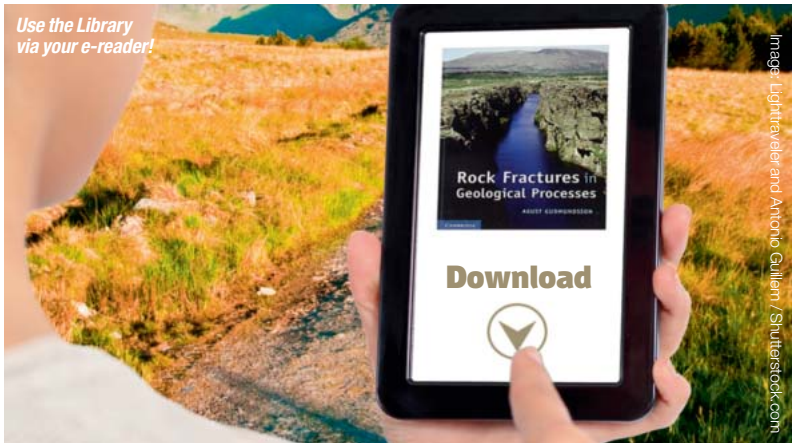
Sponsor a Fish

Thanks to everyone who has so far donated to our appeal to conserve and digitise the three thousand watercolours from the fossil fish collection of Louis Agassiz.

➤ More information about the appeal can be found at www.geolsoc.org.uk/sponsorafish

SOCIETY*NEWS...*

New E-book Collection



The Library is delighted to announce the launch of its first e-book collection for Fellows, *says Michael McKimm*.

Twenty e-books are now available via Dawsonera, a platform which includes books from a wide range of publishers, and can be accessed using Athens logins (the same details used to log in to the Library's electronic journals).

Four of the books are new additions to the Library and unique to the e-book collection: *Atlas of benthic foraminifera, Hydrogeology. 2nd ed., Rock fractures in geological processes* (pictured), and *Tectonics of sedimentary basins*.

To view the titles available please visit **www.geolsoc.org.uk/ebooks**; you will find a brief synopsis of each book as well as full details of how to access it. The books can be read online or downloaded for a pre-set period, and pages can be printed and saved, subject to the copyright limit.

We have chosen titles from a range of subject areas which we hope will be of value to Fellows and we plan to expand the collection in the future. If you have suggestions for e-books we might purchase, or feedback on the new collection, please email **library@geolsoc.org.uk**.

Accessible fieldwork

Announcing 'Confronting barriers to inclusion: opening the gate to accessible fieldwork' conference.

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 - **http://bit.ly/1OOxxUv** *George Jameson*

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➤ The library is open to visitors Monday-Friday 0930-1730. For a list of new acquisitions click the appropriate link from **http://www.geolsoc.org.uk/info**

How I became CGeol

Rick Brassington*, newly elected Council member, describes how he became chartered in the early days of the 'Institution of Geologists' and why it remains important today

Back in 1968 I worked with civil engineers in the Engineers Department at the Severn River Authority. I was not regarded as a 'professional' and so had a lower status. When I heard that the Geological Society was looking at establishing a professional body for geologists I gave it my full support. Although Council of the day was in favour, there was opposition - which meant that it had to be achieved separately (albeit with some support from GSL).

Consultations

After initial consultations the Association for the Promotion of an Institution of Professional Geologists (APIPG) was established - from which the Institution of Geologists (IG) was subsequently created. IG produced rules for corporate membership that mirrored professional qualifications in other institutions like the Institution of Civil Engineers and encouraged people to join.

Geologists from all branches supported the idea, although the greatest support came from engineering geologists and hydrogeologists. In 1983 IG asked its members what was the most important thing to do, and the unanimous answer was the acquisition of a Royal Charter that would enable IG to create the qualification 'Chartered Geologist'.

IG prepared a draft Royal Charter for submission to the Privy Council, and by January 1986 this was sent for informal comment. As it referred to the possibility of a future unification between the IG and GSL, the Privy Council said that the petition should be placed on hold until that possibility was resolved. IG then approached GSL requesting that a possible merger should be explored. A joint Co-operation Committee was set up comprising three senior members of each organisation and chaired by former President Prof. Howel Francis as someone seen as neutral by both sides.

Discussions

It took some time for the Committee to gain each other's trust and for meaningful discussions to take place. It was recognised on both sides that merger would mean significant changes to both bodies and this complex process took four years to achieve. The decision whether to merge was made by the members of both bodies and in the end, IG's organisation was merged into that of the Society, losing some of its identity in the process and with the Institution's name disappearing altogether. The majority of IG members willingly gave up IG's treasured separate identity in the greater interests of the geological community. The two bodies formally 're-unified' on 1 January 1991.

With reunification, 259 members of IG who had not belonged to GSL were granted Fellowship and 586 members of IG became the first Chartered Geologists even before the reunification process was completed. The date on my certificate is 10 October 1990.

Besides the formation of the CGeol qualification, IG created many other things that are now established part of GSL including the regional groups, the Aberconway Medal, the Geologist's Directory, and *Geoscientist*, which was formerly the IG magazine *British Geologist*. The reorganisation that took place in the mid-1990s was also a consequence of the re-unification and the spirit of change that it brought.

➤ Rick Brassington has written a history of the IG, which can be read on the Society website under 'About Us' – 'History' **www.geolsoc.org.uk/history** See also **Letters**, this issue

* **Rick Brassington** is a hydrogeologist, and newly elected Council member. See also Letters, p21.

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).

> THE MAJORITY OF IG MEMBERS WILLINGLY GAVE UP IG'S TREASURED SEPARATE IDENTITY IN THE GREATER INTERESTS OF THE GEOLOGICAL COMMUNITY. THE TWO BODIES FORMALLY 're-UNIFIED' ON 1 JANUARY 1991
> **Rick Brassington**

WORKING WITH CLAY

John Mather, together with his wife **Jenny Bennett**, collect ceramics. After retiring, he decided to make them himself...

Above: ***Display of slipware pottery by Doug Fitch, made with red earthenware clay using traditional slips. Clay is dug from the field behind his workshop in rural Devon. Photograph taken at Earth and Fire International Ceramics Fair, Rufford Abbey, Nottinghamshire 2014***

We had collected ceramics for many years. On retirement, following a career with BGS, and at Royal Holloway University of London, I accepted a family challenge to try my hand at making pots myself, rather than simply criticising the attempts of others. I discovered many challenges in producing an object of beauty, whether functional or decorative, from a lump of wet clay – and found my geological background most useful.

As the potter, artist and writer Bernard Leach (1887-1979), wrote at the beginning of the third chapter of his hugely influential manual *A Potter's Book*, 1940:

"A potter's prime need is good clay. Whether [an] industrial, peasant or studio potter the raw material of which pots are made is of fundamental importance. Upon the quality of the clay depends the strength and still more the character of the finished pot."

Mud to clay

To the geologist, clay is a term used to describe the finest grade of clastic sedimentary particles, those less than four microns in diameter and invisible to the naked eye. In still-water depositional environments these very fine water-born particles derived from rock weathering settle out of suspension and, under appropriate conditions, may consolidate to form a mudrock. If this becomes plastic when wet, it is commonly also referred to as a clay, perhaps named after a locality, as for example the London Clay or Oxford

> TO THE POTTER, CLAY HAS A MUCH SIMPLER DEFINITION, BEING A DAMP PLASTIC MATERIAL THAT SETS AS IT DRIES AND CAN BE CONVERTED BY HEATING TO A HARD, WATERPROOF MATERIAL

Slipware bowl by Devon potter, Doug Fitch, made of red earthenware clay using a mold and decorated by slips using locally-sourced clays

Roger Cockram, North Devon potter, throwing a bowl

Reverse of the above bowl showing the rough stoney earthenware used

Detail of slip decoration on the bowl by Doug Fitch

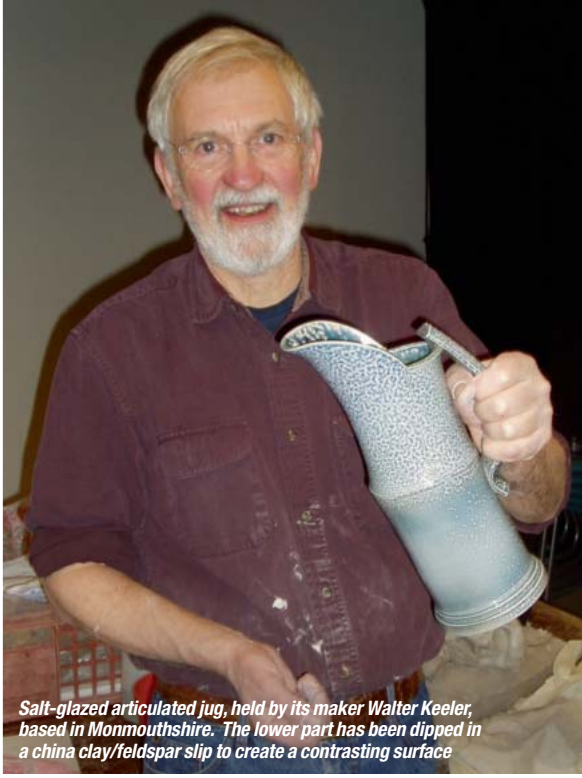
Clay, or after its potential use, as in brick clay or china clay. Although clay minerals form the main constituent, such clays also contain quartz, feldspars, micas, calcite and iron oxides, together with many other minor components.

To the potter, clay has a much simpler definition, being a damp plastic material that sets as it dries and can be converted by heating to a hard, waterproof material. Differences in mineralogy control colour, strength, texture and firing temperature. Vessels can be moulded, built from coils or sheets, thrown on the wheel or cast. Traditionally potters would have used a locally available natural clay; but now pottery suppliers can supply clays made up to a range of recipes and the choice will depend largely on the function of the finished object. For example, the clay used to form a plant pot for outdoor use is likely to be unsuitable for an afternoon tea set and production on an industrial scale will demand a clay with different properties from that used by an individual studio potter.

There are three main types of clay available to the potter, earthenware, stoneware and porcelain. Earthenware clays range widely in appearance, from brown to white depending on composition. Brown earthenware, generally described as terracotta, is coloured by iron oxides, whereas in the preparation of the fine earthenware used to make most modern tableware great efforts are made to exclude iron from the mix. The characteristic of all earthenware is that it is fired at a temperature between 1000 and 1200°C and is porous, requiring a layer of glaze to make it watertight.

'Stoneware' describes pottery that has been fired to higher temperatures between 1200 and 1300°C. At this temperature full or partial vitrification takes place, making stoneware vessels impermeable, stronger and less likely to ▶

Exeter ceramicist, Laurel Keeley, using a blowtorch to stiffen the clay before adding further coils to a handbuilt vessel



Salt-glazed articulated jug, held by its maker Walter Keeler, based in Monmouthshire. The lower part has been dipped in a china clay/feldspar slip to create a contrasting surface

Soda-glazed stoneware jug (height 25 cm) by Lisa Hammond (London) and a faceted bottle vase by Mike Dodd (Somerset) with a high silica ash glaze

High-fired commercially produced earthenware, with screen-printed design "On the Wing" by Mark Hearld for Tate. Made in England by Burleigh

chip than earthenware. A glaze is not essential but if applied will mature at the same time as the clay body, forming an integrated layer over the pot. 'Porcelain' clays are fired at even higher temperatures, between 1200 to 1400°C, producing completely vitrified ware which is smooth, strong and durable.

All these clay bodies have china clay and/or ball clay as a principal component. Both clays have a large proportion of the mineral kaolinite with smaller amounts of quartz and mica. In the UK, china clay occurs as an alteration product of the Cornubian granites, from which it has been extracted for some 250 years. It is an ideal material as it withstands high temperatures while retaining its colour. Unfortunately it has low plasticity and for this reason is usually mixed with ball clay, which is similar in composition but has far higher plasticity as a result of reworking, which produces ultra-fine clay particles.

Other materials are added to the mixed clays to improve refractoriness (resistance to heat), lower the fusion point and improve density. Refractory ingredients include flint or silica sands and those that promote fusion (known as fluxes) include feldspar and china stone. The latter is a quartz/feldspar rock, whether partially kaolinised or not, free from minerals (such as biotite) which would colour the clay body. Parts of the St Austell Granite in Cornwall, which are biotite-free, were traditionally used, hence the term Cornish Stone, often found in pottery textbooks.

An idea of simple mixtures which might be used to produce the various clay bodies is shown in the table.

The main differences between them are a reduction in the amount of clay, particularly ball clay, and an increase in

CLAY MIXTURES			
	Earthenware	Stoneware	Porcelain
Ball Clay	48%	32%	
China Clay	24%	32%	55%
China Stone (Feldspar)	24%	32%	(25%)
Flint	4%	4%	15%
Bentonite			5%

the amount of feldspar and silica going from earthenware to porcelain. The concomitant reduction in plasticity means that porcelain is more difficult to throw and work, a problem which has been overcome in the example above by the introduction of 5% bentonite to the recipe.

Plastic

Immediately after it has been modelled or thrown the clay is wet and plastic and the ware produced readily deformed. Before it can be worked further it needs to be left until it is stiff, but not completely dried out, with the consistency of hard soap. In this condition, known as 'leather hard', it can be trimmed, handles, spouts etc. can be attached, and it can be covered with a layer of liquid clay known as 'slip'. This slip may form a decoration in its own right, or coat the clay body to form a clean ground for painting and/or glazing, when it is called an 'engobe'. The ware is then left to dry out completely, when it is known as 'green ware', a state in which it can still be broken easily by hand and becomes plastic again if dipped in water. It is possible to directly apply glaze to green ware - known as raw glazing – but more generally items are fired to a temperature at which clays give up their combined water and some contraction takes place, but the body remains porous and will absorb water. This unglazed fired ware is known as 'biscuit' or 'bisque' and the temperature at which it is fired is related to the clay used and production methods.

On firing green earthenware most water has been driven off by 350°C but vapour may still be detected up until 900°C and carbonaceous material and other volatiles can remain up to 1100°C or even higher. If the biscuit ware is refired to a higher temperature than its first firing, the body will continue to react, liberating gases which, if the pot has been glazed, have to bubble through the glaze layer.

Most industrial pottery is earthenware and in order to obtain a smooth glaze finish, it is beneficial for the glaze firing to take place at a temperature lower than the bisque firing in order to prevent further decomposition and gas release causing blemishes on the glaze. Thus the industrial potter bisque fires earthenware to say 1150°C and then uses glazes that demand a lower firing temperature of about 1060°C.

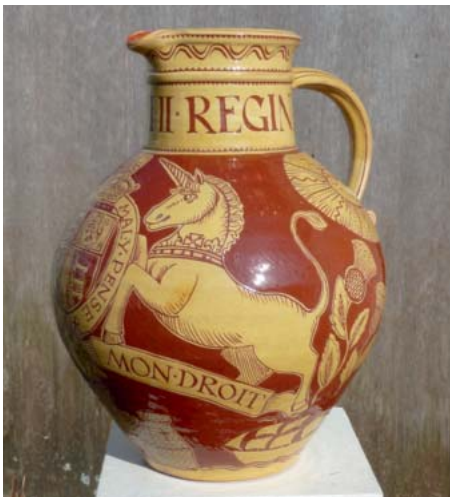
However, higher bisque temperatures reduce the porosity of the ware and most craft potters adopt a different strategy, bisque firing to around 1000°C for earthenware, stoneware and porcelain. Blemishes are healed by holding the final glaze firing temperature for 30 minutes or more, a process known as soaking.

Decorating

Decorating and glazing are generally regarded as the most difficult and unpredictable parts of ceramic production, but it is where an understanding of petrology and geochemistry proves most useful.

Glazing essentially involves putting a coating of glass on pottery, and glazes are based on three main components, glass-formers, fluxes and stabilisers. The most important glass-former is silica, which can be added directly as flint or quartz, or indirectly as a component of silicate minerals such as clays, feldspars, and wollastonite. Fluxes cause the other components to melt or flow and one of the most widely used is lead oxide. However, above about 1180°C lead increasingly vaporises which means that it can be used only in earthenware glazes.

Other commonly used fluxes are potassium and sodium oxides, usually provided by adding feldspars, and ▶



Above: Modern North Devon harvest jug by Harry Juniper of Bideford. The pot is covered with a white slip and the design is made by scratching through the slip to expose the contrasting red body – a technique known as scraffito

> IN THE UK, CHINA CLAY OCCURS AS AN ALTERATION PRODUCT OF THE CORNUBIAN GRANITES, FROM WHICH IT HAS BEEN EXTRACTED FOR SOME 250 YEARS

calcium and magnesium oxides derived from limestone, chalk and dolomite. Stabilisers reduce the fluidity of the glaze and deter devitrification. The main stabiliser used is alumina, introduced into the glaze mix in clay minerals or feldspar. In addition to these three principal components glazes may also contain colouring pigments derived from metals, such as copper, iron, cobalt and manganese. These can be used singly or in combination to obtain a variety of colours which can vary depending on firing conditions in the kiln.

For example, iron oxides might produce a warm brown in oxidising conditions and greens under reduction. Bernard Leach referred to the glass-formers as the 'bone' of a glaze, fluxes as their 'life blood', with stabilisers and other less-easily defined elements as the 'flesh' of a glaze. It is the juggling of the percentages of these three main components, and the skilful deployment of colouring oxides, which control the end product.

Glazes

Glazes are applied by mixing the mineral powders with water to the consistency of a thin cream and then dipping the bisque-fired ware in a bucket of glaze or by brushing or spraying. The powders need to be finely milled so that they can be kept easily in suspension. It is also possible to glaze pots within the kiln during the firing process. The most common example is the 'salt glazing' of stoneware, where salt is introduced into the kiln when temperatures reach about 1100°C. The salt volatilises to hydrochloric acid and sodium oxide. The acid is lost from the kiln and the sodium oxide reacts with pot surfaces, producing a skin of sodium aluminium silicate. The orange-peel effect obtained is extremely attractive and colouring oxides can be applied to give a range of colours.

As well as colouring glazes, metal pigments can be used to decorate ware either over or under the glaze. A wide range of colours is now available, but at stoneware and porcelain firing temperatures many of these colours tend to vaporise and are suitable only for earthenware. With stoneware the clay body and glaze form an integrated layer and the quality and colour of the glaze are derived partly from the body beneath. In consequence iron particles in the body will show up as brown specks through the glaze and the resulting colour range tends to be more muted than that of earthenware.

It is possible to use materials apart from rocks and minerals in glazes. The most common are calcined animal bone, used as an opacifier, and wood ash. The latter contains fluxes in varying proportions - soda, potash, lime and magnesia, occurring as phosphates, sulphates and chlorides, which are readily broken down. There is also some alumina and silica so that the wood ash is capable by itself of glazing pottery. In practice it is too fluid, runs off the pot and needs to be combined with feldspar or clay. A simple mixture of 40% wood ash, 40% potash feldspar and 20% ball clay makes an effective glaze mixture and by replacing all or part of the ball clay with a local alluvial clay or by ground Ordovician slate from one of the Cumbrian quarries, I have produced a variety of colours and finishes, firing under reducing conditions. If the kiln is wood-fired, interesting effects can also be obtained by allowing wood ash to settle on pots in the kiln during the firing process.

Dorset potter, Tim Hurn, throwing a stoneware bottle, with finished items

Stoneware bottles by Tim Hurn. Using a wood-fired kiln, ash settles and melts on the pots; together with the effects of salt introduced in the rear of the kiln, producing unique effects

Reducing

My own practice involves firing functional stoneware pots, under reducing conditions, using a gas-fired kiln. Although it is possible to generate reducing atmospheres in an electric kiln, this is not a trivial task and such atmospheres are most easily generated in kilns fired by solid fuels, oil or gas, by reducing the amount of air to less than that required for full combustion. Inadequate combustion results in the formation of carbon (black smoke coming out of the kiln chimney) and carbon monoxide. At the high temperatures present in the kiln these are chemically active, seeking oxygen from any available host, including the metal oxides in clay bodies and glazes. As a consequence copper, added to the glaze mix as the carbonate, produces a red colour instead of green, and red iron oxide, as hematite, will give greys and blacks as it is reduced to magnetite, under the right conditions yielding the luscious black glaze, which breaks to rusty brown on the edges, known as 'tenmoku'. Small amounts of iron will produce the green tints, from pale green to dark olive, known as 'celadon', named after the hero in d'Urfé's 17th Century French pastoral romance *L'Astrée*, who wore clothes of this colour.

Leach tradition

Most of my pottery belongs to what has become known as the Leach tradition. Bernard Leach (1887-1979) was born in Hong Kong and spent much of his youth in the Far East. He established a pottery at St. Ives in Cornwall in 1920 and was heavily influenced by Chinese stoneware and Japanese ceramics. Assisted by his son David (1911-2005), the standard ware which the pottery developed rejected highly decorated crockery with its impractical handles and produced a stoneware range, combining traditional forms and modern materials, with minimal decoration and celadon and tenmoku glazes.

Making up one's own glazes and using them to decorate simple, practical and functional pots is extremely satisfying. The minerals and rocks used in the preparation of clays and the generation of glazes (melts), such as kaolinite, potash feldspar, flint and limestone are all well known and the geologist starts with an inbuilt advantage when experimenting with ceramic materials and trying to understand how they might combine and interact.

Being able to produce an attractive object from a lump of wet clay and a selection of mineral and rock powders is an enviable skill, one I might have been able to achieve if I had started 50 years ago instead of 10! ◆

ACKNOWLEDGEMENT
All ceramics featured from the collection of **Jenny Bennett** and **John Mather**. Pictures by **Jenny Bennett** or **John Mather**.

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Vase with rutile glaze (28% potash feldspar, 24% flint, 16% china clay, 15% dolomite, 10 chalk, 7% rutile) made by the author

Jug with wood ash glaze (40% wood ash from wood-burning stove, 40% potash feldspar, 10% ball clay, 10% terracotta) made by the author

Jug with wood ash glaze (40% wood ash, 40% potash feldspar, 20% powdered Ordovician slate from Honister, Cumbria) made by the author

GOE FIGURE

Matthew Warke*, Gloyne Research Fund winner, investigates the Palaeoproterozoic rise in oxygen on the Kaapvaal Craton

The first half of the Palaeoproterozoic (c. 2.5 – 2.0Ga) was a period of extensive environmental change on Earth. Arguably the most significant change during that period was the irreversible establishment of an oxidised atmosphere and hydrosphere between 2.45 and 2.32 billion years ago, the period known as the 'Great Oxidation Event' (GOE), during which atmospheric oxygen concentrations rose above 10^{-5} PAL (Present Atmospheric Level) for the first time.

The rise was sufficient to cause a significant change in the geochemical cycling of sulphur in Earth's fluid envelopes and thus produce a distinct geochemical signal that indicates an oxidising atmosphere[1]. This signal has been used to trace the onset of the GOE in Palaeoproterozoic units across North America, Fennoscandia, Western Australia and southern Africa.

There is still much we don't know about the GOE. Aerobically photosynthesising cyanobacteria evolved and were producing oxygen sometime prior to 2.65Ga[2]. Oxygen started to accumulate in depositional environments when the cyanobacterial organic matter was rapidly buried; this permitted the oxygen produced in photosynthesis to escape back-reaction to carbon dioxide through respiration. Why, then, did it take approximately 200-300 million years to establish an oxidised atmosphere? Various biological and tectonic hypotheses have emerged to address this question, each discussing either the sources of oxygen (e.g. the evolution of photosynthesis in cyanobacteria) or potential physical and chemical sinks of free oxygen[3].

New data

In order to best evaluate these hypotheses there is a need for new geochemical data from successions deposited prior to the GOE. Such data may elucidate the processes in operation between the evolution of aerobic photosynthesis and the GOE. However, it is highly important that such data are collected within the context of petrological and geochemical data that explore the diagenetic and/or metamorphic processes that may have affected the geochemistry of the rock post-depositionally, and thus altered any primary oxygenation signal. It is also crucial that we examine the sedimentology of these rocks so that we can better understand the evolution of the basins and depositional environments in which they were deposited.

My PhD research focuses on three South African successions deposited on the Kaapvaal Craton (South Africa) in the early Palaeoproterozoic. Of these successions, the Tongwane and lower Duitschland formations in the Transvaal basin, and the Koegas Subgroup in the Griqualand West basin, were deposited prior to the GOE, whereas the upper Duitschland Formation (Transvaal basin) postdates it.

Our aim is to understand how oxygen began to build up in depositional environments on the Kaapvaal Craton before the GOE. We aim to contribute new sections, new geochemical datasets and, where possible, new geochronological constraints on the Transvaal Supergroup that may assist in future attempts at regional and global stratigraphic correlation. We also aim to produce new (or refined) depositional and diagenetic models of these successions.

Koegas Subgroup

With these aims in mind I set off for my second field season in South Africa in late May 2014. I was to spend just over three weeks in the field studying the Koegas Subgroup and the overlying Makganyene Diamictite in Northern Cape Province before returning to Johannesburg in June to begin two weeks of geochemical work in the labs at the University of Johannesburg (UJ).

For the first four days of my excursion I was accompanied by Professor Nic Beukes (UJ), and a field assistant, UJ MSc student Conrad de Kock. Nic led us on a comprehensive tour of the Koegas and Makganyene as exposed around the quiet settlements of Prieska and Griquatown. This eerily beautiful - and very rural - ▶

Above top: *Farm Pannetjie, just outside Griquatown, site of laterally impersistent Doradate Conglomerate*
Above middle: *Stromatolitic bioherms on the farm Taaibosfontein*
Above lower: *Landscape typical of the Koegas Subgroup*

Left: *Farm Klooffontein, north of Prieske, site of a puzzling outcrop of carbonates and diamictites*

> "WHY, THEN, DID IT TAKE APPROXIMATELY 200-300 MILLION YEARS TO ESTABLISH AN OXIDISED ATMOSPHERE? VARIOUS BIOLOGICAL AND TECTONIC HYPOTHESES HAVE EMERGED"

Makganyene Diamictite overlies, and underlies, the brecciated carbonate

part of Afrikaans-speaking South Africa is dry and dusty, its strikingly bright orange soils derived from windblown Kalahari sands.

The Koegas Subgroup is composed of seven formations[4] ranging in composition from iron-formation to sandstones, siltstones, mudstones, and minor carbonates in the form of 'stromatolitic bioherms'. Stromatolitic bioherms form a prominent marker bed which we (by - carefully - picking our way through *swarthaak* ('black-hook') bushes) traced and mapped for just over two kilometres across the Taaibosfontein farm. Sections of the Koegas were logged here and on neighbouring farms and samples gathered for petrographic and geochemical analysis in Manchester.

Makganyene Diamictite

The contact between the Makganyene Diamictite and the underlying Koegas Subgroup is also exposed on Taaibosfontein. The Makganyene Diamictite is a world-renowned glacial deposit and has been argued as evidence for a Palaeoproterozoic 'Snowball Earth' episode[5]. Established stratigraphic models place a significant 150myr hiatus between the deposition of the Koegas and the Makganyene. However, some workers have argued that "lenses" of Makganyene reported from within the lower Koegas show that the two units are coeval, lateral equivalents[6].

This would imply that the Makganyene Diamictite was deposited immediately prior to the GOE and not c.100 million years afterwards, as is widely thought. If correct this 'older Makganyene' scenario would have serious ramifications for any 'cause and effect' relationship between the GOE and a Palaeoproterozoic Snowball Earth.

However this is extremely doubtful. Across the Northern Cape the glacial unconformity at the base of the Makganyene cuts down into the Koegas at several stratigraphic levels[7] and striated pavements are visible beneath the diamictite on Taaibosfontein. On the isolated farm Klooffontein, north of Prieska, Nic and I debated a puzzling outcrop of carbonates and diamictite. While Nic envisages the diamictite draping an upper Koegas karst surface, it seems more likely that the carbonates - which are heavily brecciated, discontinuous, and are overlain and underlain by diamictite - are isolated blocks of Koegas carbonate (several metres wide) which have been entrained into the diamictite.

In either case our field evidence seems to indicate that the carbonates became lithified prior to glacial erosion. Thus we do not consider the Koegas and Makganyene to be coeval, though our evidence is limited and we are unable to quantify the length of the hiatus between the deposition of the Koegas and the Makganyene. Thus we cannot rule out the possibility that the Makganyene may be significantly older than currently thought, and may correlate with a postulated 'cryptic glacial horizon' within the Duitschland Formation[8]; this horizon also marks the onset of the GOE as recorded in South Africa.

So, what are these "lenses" of Makganyene? Given their reported stratigraphic position within the Koegas they are likely to be exposures of a conglomerate member that occurs at the base of the Doradale Iron Formation (Koegas Subgroup). The Makganyene and basal Doradale conglomerate are superficially similar, both being matrix-supported, massive units with chert and carbonate clasts ranging widely in size and sphericity; they also have a similar weathering profile.

However, unlike the Makganyene, the Doradale conglomerate (as seen on Pannetjie farm just outside Griquatown) is not laterally persistent. It is lenticular in nature and often only exposed for 1-10m before thinning laterally into low-energy iron formation; it may represent higher-energy channelised deposits within the iron formation.

Summary

As our petrological and geochemical analysis continues, we expect that our samples from the Koegas Subgroup will prove useful in understanding both the rise in oxygen on the Kaapvaal Craton (prior to the GOE) and the diagenesis of the Koegas succession. Our field observations have helped to address some of the sedimentological and stratigraphic problems that persist in Griqualand West, but there remain many unaddressed stratigraphic problems (such as a lack of absolute age data and robust stratigraphic correlations) which will limit our understanding of how oxygen may have arisen in these environments.◆

ACKNOWLEDGEMENT

I would like to thank the **Geological Society** for financial support through the Gloyne Outdoor Research fund. I would also like to thank **N. Beukes, C. Vorster**, and **C. de Kock** for field, laboratory and/or logistical support and the staff of the **Geology Dept., University of Johannesburg** for their hospitality.

Stromatolitic bioherms on the farm Taaibosfontein attaining a maximum thickness of approx. 2 m.

Striated pavement beneath the Makganyene Diamictite on the farm Taaibosfontein

Farm Taaibosfontein, with its delightful 'swarthaak' bushes

Doradate Conglomerate (Koegas Subgroup)

Unstratified and massive Makganyene Diamictite with large chert clasts of mixed sphericities

*Matthew Warke is at Manchester University matthew.warke@manchester.ac.uk. For more information on the Society's fieldwork research funds, please go to 'Awards, Grants & Bursaries' in 'About Us' on www.geolsoc.org.uk.

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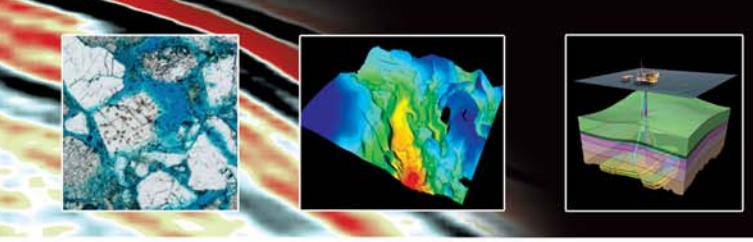

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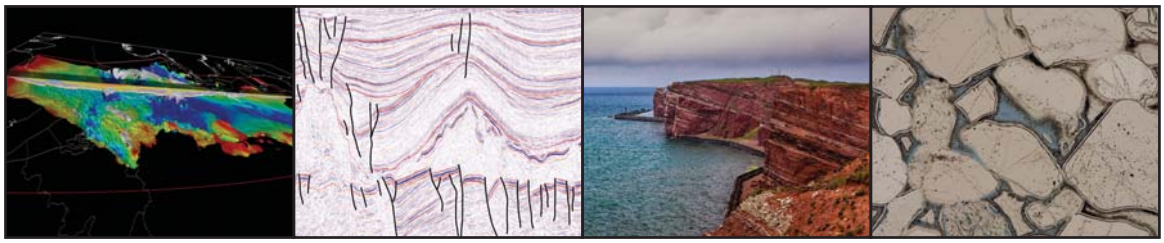
7-9 September 2016

Burlington House, Piccadilly, London



Convenors:

Ben Kilhams
Shell Netherlands and Petroleum Group

Peter Kukla
RWTH Aachen University

Stanislaw Mazur
Getech UK

Tom McKie
Shell UK

Harmen Mijnlieff
TNO

Kees v. Ojik
NAM/Argo Geological Consultants

Robert Schöner
LBEG

The Southern Permian Basin covers a large geographic area of northern Europe including the UK, Netherlands, Germany, Poland, Denmark and Sweden. For many operators it has, and continues to be, a heartland for hydrocarbon production from the Rotliegend sandstones and overlying Zechstein carbonates. However, in this mature basin many opportunities remain within the overburden and particularly within the Mesozoic succession associated with heterolithic source rock, reservoir and seal facies' and complex tectonics characterized by extension, compression, inversion and halokinesis. Interest in this interval has also increased due to its geothermal potential, especially in the Netherlands. In this conference, we aim to bring together academics and industry workers from across the region to share ideas on the following themes:

- Regional cross-border stratigraphic correlation.
- Sedimentology including reservoir/seal extent, facies and diagenesis.
- Structural evolution and styles.
- Regional and local-scale hydrocarbon generation and charge.
- Examples of geothermal developments in the basin.
- Hydrocarbon field-scale observations (including geophysical, petrophysical and production data) and their application to further exploration, hydrocarbon/geothermal development within the Mesozoic.

This is a 3-day meeting including:

07/09/16: Field excursion to the Lower Cretaceous of Surrey and Sussex (led by Martin Wells, BP). Evening Icebreaker Drinks, Piccadilly, London.

08/09/16: Regional overview and Triassic of the Southern Permian Basin; Oral and Poster Programme.

09/09/16: Jurassic and Cretaceous of the Southern Permian Basin; Oral and Poster Programme.

Event Sponsor:

Call for Abstracts:

Please submit abstracts for oral and poster contributions that cover any of the above themes to laura.griffiths@geolsoc.org.uk and b.kilhams@shell.com before 29 February 2016

For further information please contact:

Laura Griffiths, The Geological Society, Burlington House, Piccadilly, London W1J 0BG. T: 020 7434 9944

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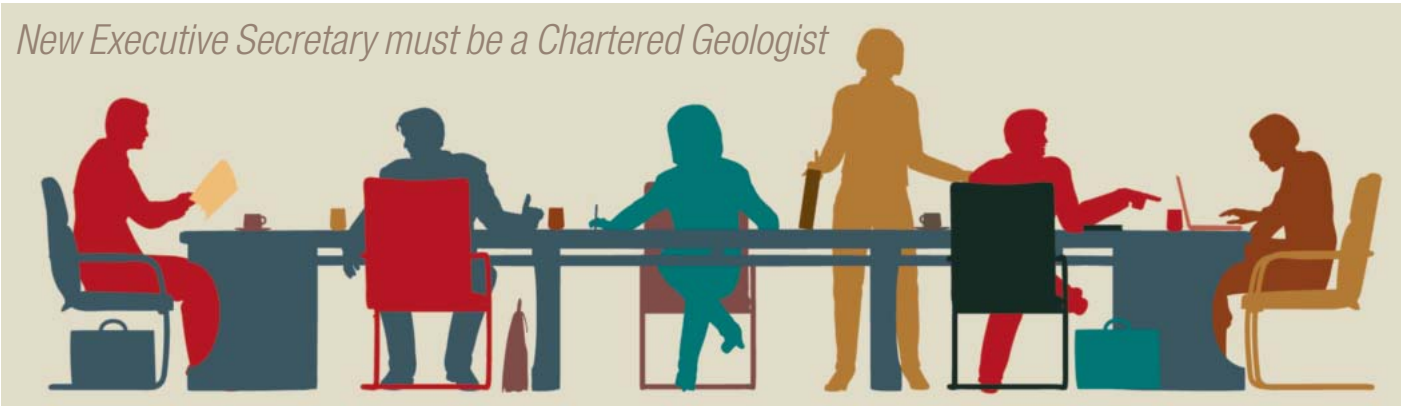
READERS' LETTERS

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**

New Executive Secretary must be a Chartered Geologist



Sir, I chaired the Governance Committee in 1996 that constituted the five Vice-Presidents and myself. Our report to Council recognised the important role of the Executive Secretary in representing the Society and furthering its aims for the science and profession of geology at a high level both in the UK and internationally. The Executive Secretary provides an important continuity within the Society's governance as the Bye-laws dictate that Presidents, Honorary Officers and Council Members may only serve for a limited time. For these reasons the Governance Committee recommended that the Executive Secretary should be a professionally experienced Chartered Geologist.

Reading the recently published recruitment advertisement in the April issue of this magazine, it would seem that, 18 years later, this important aspect of the role of the Executive Secretary may have been overlooked and this requirement has not been included in the Bye-laws during the various reviews that have occurred during recent times.

I hope that this aspect will not be overlooked by the committee charged with making the appointment and am reassured by the comments made by the President in response to the letter from Dick Selley published here last month.

RICK BRASSINGTON

Playing Against Nature

Books about natural disasters and disaster mitigation tend to focus either on their scientific or political/economic aspects. Thus, earthquakes are considered either as geological and seismological phenomena or as risks to lives, property and urban infrastructure.

Playing Against Nature impressively integrates both aspects. Seth Stein is a seismologist - professor of geological sciences at Northwestern University - with a keen interest in US public policy towards earthquakes; Jerome Stein (father of Seth) was, until his death, an academic economist with an interest in science. Their book, the product of many years' interaction, is a textbook intended for upper-level undergraduate or graduate courses, which will also appeal to instructors, researchers and practitioners interested in geoscience, engineering, economics or policy issues relevant to natural hazards. Although the emphasis is on earthquakes, the authors cover other natural hazards. Some chapters involve considerable mathematics, but this is seldom crucial to their argument.

Among their many questions for discussion is the risk from Italy's Mount Vesuvius. "Since the last eruption in 1944, the Bay of Naples region has been a hotbed of construction—much of it unplanned and illegal—that has hugely increased the number of people living in the danger zone of the volcano" they note. Millions may be affected by the next eruption, especially those living in the *zona rossa* (red zone). The Italian authorities are considering the idea of paying these people to relocate. "How would you formulate and evaluate such plans?"

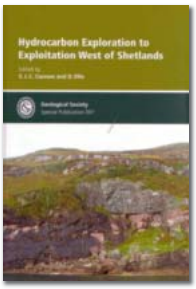
Another question concerns earthquake risk in the US Midwest. In January 2011, the US Department of Homeland Security's Federal Management Agency (FEMA) issued a call to vendors to provide meals for a survivor population of seven million in the event of a repeat of the severe Missouri earthquakes of 1811-12, one of which temporarily reversed the course of the Mississippi River. This invitation was promptly cancelled, without explanation, when the news media showed interest. "Estimate how much FEMA was planning to spend. What questions would you have asked if you were in the news media?"

Seth Stein's view, strongly advocated in the media since the 2011 bicentenary, is that a repeat is extremely unlikely, on the basis of his team's GPS-based regional strain measurements. Money would be far better spent on improving local education and health care than on seismic retrofitting of buildings in Memphis, says Stein. Other seismologists are less sure. Read *Playing Against Nature* and make up your own mind about such risks and society's most valid response.

Reviewed by ***Andrew Robinson*** *(Author of Earthshock and Earthquake: Nature and Culture)*

PLAYING AGAINST NATURE: INTEGRATING SCIENCE AND ECONOMICS IN AN UNCERTAIN WORLD
SETH STEIN AND JEROME STEIN, 2014.
Published by: The American Geophysical Union and Wiley 260pp (hbk) ISBN: 9781118620823
List price: £45.00 www.wiley.com

Hydrocarbon Exploration to Exploitation West of Shetlands



Oil West of Shetland once again hit the headlines recently with the Scottish independence referendum. Thus, despite the fact that this Geological Society Special Publication was based on a 2011 conference, its release in mid-2014 feels quite timely.

As Special Publications go, this is a rather thin volume, at only 229 pages. It comprises 12 papers (plus an introduction), of which 10 are written by scientists working in the petroleum industry, giving it a different tone to many other special publications authored by academics.

Many papers concentrate on case studies and stories from individual fields or exploration campaigns. Laggan, Foinaiven, Glenlivet, Tornado, Lancaster and Cambo are discussed across several papers from either an exploration or an appraisal viewpoint. A separate paper by Loizou discusses the contrasts between some of the aforementioned exploration successes, and exploration failures such as the Assynt prospect. A key message from this section is an over-reliance on geophysics over the underpinning geology, or unsuitability of older geophysical data, led to many exploration failures in the basin.

Further papers in the publication describe the influence of sills on reservoir sand occurrence, the results of reprocessing older seismic to see through basalt cover, the use of formation micro-imaging tools for volcanic facies identification, the use of detrital zircons to date basement history in Rockall and new workflows for cuttings analysis in large igneous provinces. In general these are snappily written, well-argued papers with some very interesting ideas.

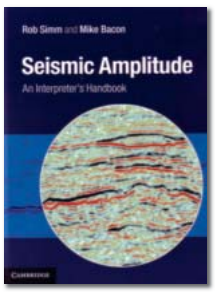
I found the volume both interesting and valuable, however it was surprising as a reviewer to have to flick through 180 pages before finding the first photo of real rock. In fact, no papers look at field analogues for any plays. Yet, despite its small size, the volume is of high quality and contains excellent discussions of both successes and failures in exploration West of Shetland. Images are also of high quality and, particularly in the case of the seismic lines over individual discoveries, hard to find elsewhere.

However the volume could be more complete – some of the biggest problems with exploration in the basin (e.g. interpretation of base basalt), and some of the biggest debates (mantle plumes, spatial occurrence and prospectivity of Palaeozoic sequences, etc.) are under-explored. Overall, I would happily recommend this volume as an excellent addition to the Special Publications series.

Reviewed by ***Murray Hoggett***

HYDROCARBON EXPLORATION TO EXPLOITATION WEST OF SHETLANDS
S J C CANNON and D ELLIS (Eds). 2014 Geological Society Special Publication 397, 229pp. ISBN 978-1-86239-652-4. **List price: £90.00 ; Fellows' price: £45.00. www.geolsoc.org.uk.**

Seismic Amplitude - an interpreter's handbook



This book provides a comprehensive overview of the basics theory of seismic amplitude and a practical guide to the methods of seismic amplitude interpretation for the identification and

location of hydrocarbons and reservoir characterisation.

It includes more advanced interpretation techniques such as Amplitude Versus Offset (AVO) analysis, seismic inversion and rock physics modelling as well as detailing multiple applications of such methods illustrated by data examples from around the world. Simm and Bacon initially examine the fundamentals of seismic reflectivity and modelling theory for seismic interpretation, including seismic polarity, phase, wavelets and resolution.

The full mathematical equations are provided at all stages but they do not overwhelm the reader. The reasons and methods for performing well tie analysis are discussed in the following chapter. These earlier topics are clearly explained and underpin the more advanced discussions on amplitude and AVO interpretation, rock physics for seismic modelling and seismic trace inversion.

The majority of the book focuses on these more advanced techniques and their basis in the relationship between rock properties, seismic amplitude and AVO analysis. The rock properties and rock physics chapters show the reader how the interpretation of seismic data relates to real-world geological and geotechnical parameters. The seismic amplitude applications section is likely to be of particular interest to active interpreters with topics including the derivation of litho/fluid-facies and reservoir properties from seismic data, time-lapse seismic and the use of amplitudes in prospect evaluation.

The estimation of reservoir properties from deterministic inversion, simple regression, calibration and uncertainty, mapping using geostatistical techniques, as well as net-pay estimation are discussed. Items such as the time-lapse feasibility scorecard and Direct Hydrocarbon Indicators (DHI) checklist are handy references for active interpreters. The authors display their extensive industry experience throughout this book, while all terminology is simply and clearly explained. A large number of references are also included to direct readers to further associated literature.

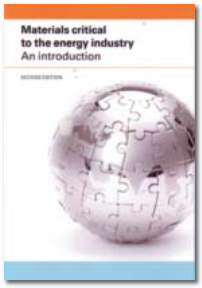
This small hardback book is logically laid out and contains many informative colour data examples from around the world. Included throughout the numerous figures illustrate the text well and help make this book a suitable practical guide for students and beginners as well as an excellent reference for more experience geoscience professionals.

This book is well written and is very good value at such a reasonable price; I would recommend it for anyone looking to find out more about this subject.

Reviewed by ***Caroline Mason***

SEISMIC AMPLITUDE: AN INTERPRETER'S HANDBOOK
ROB SIMM AND MIKE BACON, 2014 Published by Cambridge University Press. Hbk. ISBN 978-1-107-01150-2 271pp
List Price £45.00 www.cambridge.org

Materials critical to the energy industry



Meaningful conversations on the wasteful use of resources, and whether the resources themselves will soon Meaningful conversations on the wasteful use of resources, and whether the resources themselves will soon be used up, require facts. Materials critical to the energy industry provides plenty.

This book, generously credited to 'Zepf *et al*.' but in fact almost entirely the work of one, John Simmonds, gives the quantities and factors affecting the supply of naturally occurring materials that the energy industry uses. It works systematically through from geological/geographical sources to finished products, the so-called energy pathway. There is an informative introductory chapter on needs, provenance, extraction, production and usage. All useful lecture-room discussion-starters!

Then there are two-page spreads in legible print and clear diagrams on 23 elements, covering uses in the energy sector, properties and origins, sustainability, reserves, trade, ecological impact, processing, importantly 'substitutabity' and recycling, with summary tables of producers, yearly production quantities and prices. Finally come glossary, references and extra data-tables.

The book concentrates on the 23 elements with significant applications in the energy industry. Selected rare earths are taken together (10/17 of the set). The rationale behind the selection is that materials should form part of a final product (rather than be used somewhere along the energy pathway) or be in danger of short supply. Hence, the elements that help create exotic steels (e.g turbine blades), catalysts for product conversions and dopants for electronic semiconductor components are considered; but zinc, tin, iron, manganese (no shortage) or mercury or gold (not in final products) are not.

The layout and the clarity of the prose and illustrations all win. The book's style reminded me of my school inorganic chemistry book. Its 90 pages are full of facts capable of substantiating any debate now, or for decades to come. It would also be a useful source of facts and figures for quiz enthusiasts, whether for Mastermind or the local pub-night on science topics, particularly inorganic or industrial chemistry. If all the facts in this book could be retained, one would indeed be an expert!

If this is your area of interest (e.g. as a policy maker, regulator, business, academic or concerned citizen) then this book should be on your reference shelf. And better still, since it is based on sponsored research work by the Resource Strategy Department at Augsburg University, southern Germany, it forms part of BP's Energy Sustainability Challenge, and can be downloaded free - see below. I am enjoying learning from it.

Reviewed by ***Richard Dawe***

MATERIALS CRITICAL TO THE ENERGY INDUSTRY - AN INTRODUCTION (2ND EDITION)
ZEPF *et al*., Published by BP plc, London, UK as part of a series that reflects the work of BP-sponsored Energy Sustainability Challenge, 2014. 90pp sbk. ISBN 978-0-9928387-0-6 May be downloaded here:
http://on.bp.com/1EQjlGl

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! The Role of Volatites in the Genesis, Evolution and Eruption of Arc Magmas** by Zellmer *et al.* Geological Society Special Publication #410.
- **NEW! Geodynamic Processes in the Andes of Central Chile and Argentina** by Sepulveda *et al.* Geological Society Special Publication #399
- **NEW! Ore Deposits in an Evolving Earth**, by Jenkin *et al.* Geological Society Special publication #393
- **NEW! Fundamental Controls on Fluid Flow in Carbonates** by Agar *et al.*, Geological Society Special Publication #406

PEOPLE *NEWS*

CAROUSEL

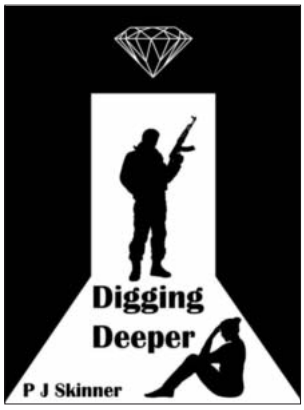
All Fellows of the Society are entitled to entries in this column. Please email ted.nield@geolsoc.org.uk, quoting your Fellowship number.

◆ John Christopher Wolverson Cope

John Christopher Wolverson Cope, National Museum of Wales, Cardiff, has been awarded the Glasgow Geological Society's 2015-16 T Neville George Medal in recognition of his "outstanding achievement in the fields of palaeontology and stratigraphy".

◆ Pippa Jeffcock

Pippa Jeffcock (aka 'P J Skinner') has published a novel entitled Digging Deeper, about a geologist who goes to work in the diamond fields and is kidnapped by rebels. It is available in paperback and on Kindle/digital reader. Anyone posting a review on Amazon may have a free copy of the second in the series, when it is completed, by claiming it on the Digging Deeper Facebook page.



IN MEMORIAM WWW.GEOLSOC.ORG.UK/OBITUARIES

THE SOCIETY NOTES WITH SADNESS THE PASSING OF:

Barker, R W N *

Nicolson, Robin

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**.

◆ Hugh Torrens

Hugh Torrens, Emeritus Professor, Keele University, unveils a plaque commemorating William Smith's birthplace in Junction Road, Churchill, Oxfordshire. The plaque was erected by the Churchill and Sarsden Heritage Centre. Smith's 246th birthday would have been 23 March in a year that also marks the bicentenary of the publication of Smith's geological map of England and Wales. The plaque was paid for by the Curry Fund of the Geologists' Association.

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

DISTANT THUNDER

Dizzy heights

Image: Zocchi Roberto / Shutterstock.com

Mont Blanc and the Aiguille Noire

Image: From *The annals of Mont Blanc, a monograph* 1900 by Mathews, Charles Edward. From a picture by Juehl. [Public domain], via Wikimedia Commons

Horace Benedict de Saussure

*Geologist and science writer **Nina Morgan*** celebrates a high point in the history of geology*

The Swiss geologist and meteorologist Horace Bénédict de Saussure [1740-1799] is not the only geologist who was drawn to the subject because of his love of high mountains. But, one could argue, he took his passion to new heights. Sometimes referred to as the Father of Alpinism, he reached the summit of Mont Blanc in 1787, accompanied by 18 guides and a number of scientific instruments. Although not the first party to reach the top, his expedition caught the popular imagination. Some even suggested that Mont Blanc be renamed in his honour.

International glory

It also won him an international reputation among scientists. During his 14 trips in the Alps Saussure carried out experiments on heat, cold, the weight of the atmosphere, electricity and magnetism. He also studied Alpine geology, and identified 15 'new' minerals, discoveries that led him to realise that the composition of all rocks is not the same. An early adopter of the term 'geology' in the modern sense – the word was used earlier to distinguish heavenly matters from earthly ones – Saussure was also a firm believer in the Neptunian theory. But at the same time, his observations of rocks, erosion and fossils in the Alps convinced him that the Earth was much older than generally thought.

Although Saussure never got round to writing a formal synthesis of his geological ideas, the last volume of his major four-volume work, *Voyages dans les Alpes, précédés d'un essai sur l'histoire naturelle des environs de Genève*, published between 1779 and 1796 gives insights into his way of thinking. Saussure became convinced that study of the present would be the key to understanding the Earth's past and predicting its future. His observations provided James Hutton [1726 – 1797] with some of the fundamental documentation Hutton used to formulate his own theories.

Image: Photo courtesy of Mike Tomlinson

Saussurite in a migmatite gravestone in Headington Municipal Cemetery in Oxford

Posthumous fame

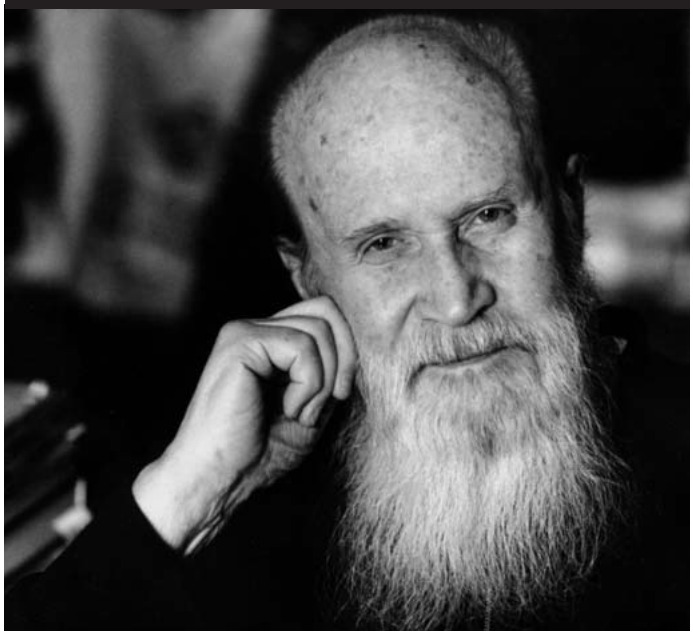
To the proverbial citizen on the street in Switzerland, Saussure remains a familiar figure because his portrait appears on the blue 6th series 20 Franc Swiss banknotes which are still legal tender. For geologists and mineralogists his name also lives on in many modern cemeteries. One of the minerals he discovered, saussurite, a hydrothermal alteration product of plagioclase feldspar, is responsible for the striking green colour of some of the more spectacular gravestones made of metamorphic rocks!

Acknowledgement
A visit to Headington Municipal Cemetery with **John Dewey** provided the inspiration for this vignette. Other sources of information include entries for **Horace Bénédict de Saussure** at **encyclopedia.com**, **wikipedia.com**, and at **www.mtholyoke.edu/courses/rschwart/hist257s02/students/Anna/Saussure.htm**; articles about Swiss currency on Wikipedia; and about the etymology of the term 'geology' in the Oxford English Dictionary.

***Nina Morgan** is a geologist and science writer based near Oxford

OBITUARY BORIS SOKOLOV 1914-2013

Distinguished geologist and palaeontologist, expert on fossil corals and 'Godfather' of the Vendian Period



Boris Sergeevich Sokolov, Russian Academician and Honorary Fellow of the Geological Society, died September 2013 just a few months before his centenary.

Boris Sergeevich was one of the most outstanding Russian personalities in Earth Sciences in the second half of the 20th Century. His interests, including palaeontology, stratigraphy, regional geology, palaeogeography, facies analysis etc., were "guided by my curiosity…it was a zigzag path" he said (1992). He is well known globally for his pioneering work on Palaeozoic corals and contributions to Upper Precambrian stratigraphy. He authored more than 600 scientific papers, including 12 monographs.

> HE IS WELL KNOWN GLOBALLY FOR HIS PIONEERING WORK ON PALAEOZOIC CORALS

Vendian

Boris graduated from Leningrad University (1936) and was sent on a major research project into Central Asia and China. He distinguished himself there as a talented geologist and manager, and his contribution formed a firm base for assessing oil and gas prospects. Returning home (1948) he published five volumes (1951–55) on *Palaeozoic Tabulates of the European part of the USSR*, a classic source that inspired research on fossil corals globally, leading to wide international cooperation and regular conferences. Then followed studies of core material from the deep drilling program on the Russian Platform, including a major discovery that changed global stratigraphy. Sokolov recognised a new geological 'system' - the 'Vendian'. This had a major impact on our understanding of the evolution of life and geostructures through the Late Precambrian, despite the IUGS's preferred name, 'Ediacaran'.

In 1958 he was organising the Department of Palaeontology and Stratigraphy at the Institute of Geology and Geophysics, Siberian Branch of the Academy of Sciences, Novosibirsk. In 1975 he was elected (staying 15 years, longer than anybody else!) Academician-Secretary of the Division of Geology, Geophysics, Geochemistry and Mining Sciences of the Academy of Sciences. This meant that he was 'in charge' of these disciplines in all academic institutions in the USSR. He also established the only Laboratory of Precambrian Palaeontology in Russia, (Palaeontological Institute, Moscow).

He led several pioneer research programs in Earth sciences and several international projects within IGCP (IUGS/UNESCO). He was long-standing chairman of the Interdepartmental Stratigraphical Committee of the Russian Federation, President of the All-Russian Palaeontological Society, President of the International Palaeontological Association, and a member of various commissions of the IUGS Commission on Stratigraphy. His open-minded and democratic manner made him very popular, especially over tough issues like the Silurian–Devonian Boundary!

Lenin Prize

Laureate of the Lenin Prize and a Hero of Socialist Labour, Sokolov was awarded many USSR orders and medals, as well as the A P Karpinsky Gold Medal to go with his international Karpinsky–Schweitzer prize (Hamburg Foundation). His great contribution to science and to the Academy is noted by the M V Lomonosov Large Gold Medal, the Russian Academy of Sciences' highest award.

Latterly Boris Sergeevich thought increasingly about biosphere evolution and became interested in the history of science. Boris remained active in research to the end, maintained fruitful interaction with the Academy and colleagues, shared experience, and supported young scientists. His advice was, "Self-criticism, healthy doubt and curiosity are the guiding lights of innovation and new discoveries!"

By **Mikhail A Fedonkin, Dimitri Kaljo, Alexei Y Rozanov, Sergey V Rozhnov, Ekaterina A Serezhnikova.**
A longer version of this obituary is available on the website. *Editor.*

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
One day training course: Engineering Geophysics	11 June	Fugro Engineering Services. **Venue:** Fugro House, Hithercroft Road, Oxfordshire OX10 9RB. **Time:** 1000. Free. **Contact:** Steve Poulter **E:** s.poulter@fes.co.uk
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.

DIARY OF MEETINGS JUNE 2015

MEETING	DATE	VENUE AND DETAILS
How will minerals feed the world in 2050 Northern Ireland Regional	1 June	**Venue:** Ulster Museum, Belfast. **Time:** 1830 for 1900. **Speaker:** Professor David Manning, President, Geological Society. **Contact:** Mike Young E: GeolSocNI@gmail.com
The Quaternary of Southern South America QRA	2-3 June	Lecture, Workshop. **Venue:** University of Glasgow. Fees (concessions) apply. See website for details, abstract submission and registration. **Contact:** Alessa Geiger **E:** QSSA15@gmail.com
Geotour North West Highlands Geopark	3-10 June	Field trip. See website for details, fees, and booking. **Contact:** Pete Harrison **E:** pete@nwhgeopark.com
President's Day Geological Society	3 June	AGM and Awards Ceremony. See May issue and website for details and registration. **Contact:** Steph Jones **E:** stephanie.jones@geolsoc.org.uk
William Smith's Earliest Career to 1810 Bath Geol. Soc.	4 June	Lecture. **Venue:** Bath Royal Literary and Scientific Institution, Queen Square. See website for details.
Engineering Geology Field Trip Engineering Group	5-7 June	**Venue:** Holiday Inn, 22 Ormeau Avenue, Belfast. See website for details and fees. **Contact:** Richard Ghail **E:** r.ghail@imperial.ac.uk.
Field Trip to Bath Geol. Assoc.	6 June	**Leader:** Prof. Hugh Torrens. A William Smith Map Bicentenary event. See website for further information. **Contact:** geol.assoc@btinternet.com.
Fossils and Mud - A Jurassic Adventure Geological Society	10 June	**Speaker:** Neville Hollingworth. A Society London Lecture. See p6
Mining in a Crowded Country European Federation of Geologists	11-14 June	Workshop, Lecture, Field Trip, Conference. **Venue:** North of England Institute of Mining and Mechanical Engineers. Fees apply (concessions). See website for details and registration. **Contact:** Jess Aries **E:** jess.aries@geolsoc.org.uk.
William Smith Field trip. Bath Geol. Soc.	13 June	**Leader:** David Workman. **Venue:** Bath. Itinerary tbc. See website for details.
Annual XRF meeting BCA/RSC	17 June	**Venue:** University of Leicester. For details see website. Fees (concessions) apply. **Contact:** Rosalind Schwartz **E:** r.schwarz24@gmail.com
Surface water, groundwater and flooding in quarries and mines EIG	17 June	Conference. **Venue:** Stratford Manor Hotel, Warwickshire. **Time:** 0900 – 1700. See website for links. **Contact:** Geoffrey Walton **E:** Geoffrey.Walton@eigconferences.com.
26th Annual Dinner Petroleum Group	18 June	**Venue:** Natural History Museum. See website for details. For bookings, **Contact:** Annie Sewell **E:** annie.sewell@geolsoc.org.uk
Penrose Conference Geol. Soc. of America	22-27 June	**Venue:** Evanston, Wyoming. Fees apply. See website for details and registration. **Contact:** Michael West **E:** mwest@m-west-assoc.com
The UK Shale Oil and Gas Industry: licensing, planning and community engagement Westminster Energy, Environment and Transport Forum	23 June	Seminar. **Venue:** tbc. **Time:** 0900-1300. **Cost:** £210+VAT. See website. **Contact E:** info@forumsupport.co.uk
Poetry Reading Scarborough Museums Trust	26 June	**Venue:** Rotunda Museum, Scarborough. To celebrate the publication of Map: Poems After William Smith's Geological Map of 1815 (Worple Press, 2015). **Cost:** £5.00. See website. **Contact E:** rotunda@smtrust.uk.com
Confronting barriers to inclusion: opening the gate to accessible fieldwork Geological Society of London	26 June	Conference, Workshop. **Venue:** Burlington House. Fees apply (£20.00). See website for details and online registration. **Contact:** Alison Stokes **E:** alison.stokes@plymouth.ac.uk
Open Day BGS, Nottingham	27 June	**Venue:** BGS, Keyworth. **Time:** 1000-1600. Free. Booking online – see website. **Contact:** Linda Hetherington **E:** lest@bgs.ac.uk
Camborne School of Mines: Holman's Test Mine. South West Regional	27 June	Field Trip. **Venue:** Holman's Test Mine, Camborne TR14 9JW. **Time:** 1000. See website for itinerary and details. **Contact:** Sam Hughes **E:** S.P.Hughes@exeter.ac.uk.

OBITUARY YVES OSCAR FORTIER 1914-2014

Director of the Geological Survey of Canada who pioneered geological study of the Arctic Islands

Yves Fortier, former Director of the Geological Survey of Canada, was born in Quebec City on 17 August 1914, two weeks after Germany declared war on France at the outbreak of World War I. He died in Ottawa 100 years later, on 19 August 2014.

Yves obtained a BA from Laval University in 1936, a BSc in Geology from Queen's University, Kingston, in 1940, and an MSc from McGill University in 1941. His service with the Geological Survey of Canada (GSC) began in 1943 with fieldwork in the Yellowknife area. A mapping project in the Appalachians of southeastern Quebec led to conferral of a PhD by Stanford University in 1946.

Arctic

Yves was introduced to the Arctic in 1947 when he accompanied a team of geophysicists investigating Earth's magnetic field in the Arctic Islands using a Canso amphibious aircraft. The excellent exposure of bedrock in the treeless terrain made a deep impression on Yves.

After spending the summer of 1949 in gneisses of southern Baffin Island, using boats along the coast and pack-dogs on land, Yves proposed a circumnavigation by canoe of Cornwallis Island, lying in the central part of the Arctic Islands and underlain entirely by sedimentary rock. This was accomplished in 1950 in the space of one month by Yves, Raymond Thorsteinsson and Trevor Harwood in a seven-metre freighter canoe powered by a five-horsepower outboard motor.

Operation Franklin

Responding to a request by the federal Department of Indian and Northern Affairs that GSC "establish further the petroleum potential" of the predominantly sedimentary northern Arctic Islands, in the winter of 1953-54 Yves began planning a reconnaissance survey of the geologically little known Queen Elizabeth Islands, to take place in 1955. Operation Franklin, organised and led by Yves, involved 11 geologists and their support personnel, who began fieldwork in May and ended it in late September 1955. During the spring, supplies were cached at various points by ski/wheel-equipped aircraft and some geological work was done by dog-sledging. In the summer, field parties were supported – for the first time in the High Arctic – by helicopter. Results from this vast area initiated an oil and gas exploration rush in the1960s.

After occupying senior scientific managerial positions within GSC in the period 1958-64, Yves became the 13th (and first francophone) Director of the organisation in 1964, a position he held until 1973. Yves ended his career as Assistant Deputy Minister for Science and Technology in the Department of Energy, Mines and Resources and retired in 1976.

> YVES OBTAINED A BA FROM LAVAL UNIVERSITY IN 1936, A BSC IN GEOLOGY FROM QUEEN'S UNIVERSITY, KINGSTON, IN 1940, AND AN MSC FROM MCGILL UNIVERSITY

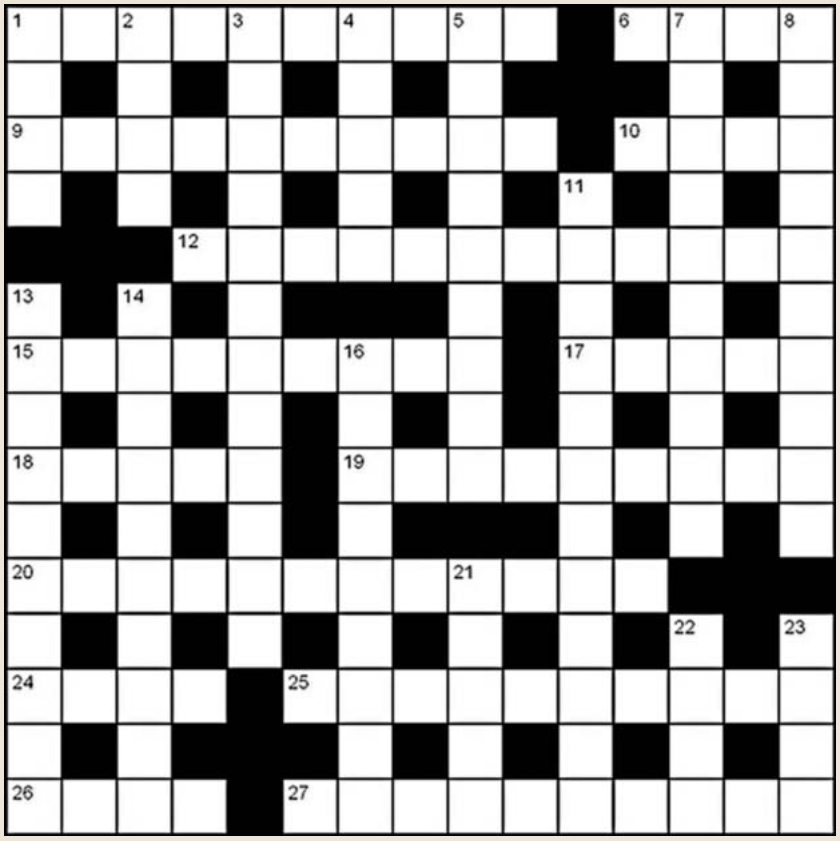
Yves was a founding member of the Geological Association of Canada, a Fellow of the Royal Society of Canada, and an Officer of the Order of Canada; held honorary membership of The Geological Society (London) and Société Géologique de France; and was awarded the Massey Medal by the Royal Canadian Geographical Society and the Logan Medal by the Geological Association of Canada. The mineral yofortierite was named in his honour.

Yves is survived by his wife Trudy, two sons and two daughters.

By **Thomas Frisch**

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.XXX SET BY PLATYPUS



ACROSS

1 Valley formed by movement on a single normal fault (4,6)
6 Molecular unit of heredity (4)
9 Giant mountain instruments (10)
10 Sharpen (4)
12 Many an Errol Flynn role, for example, swinging on chandeliers and massacring hundreds with his dashing blade (12)
15 Little men, Latinly (9)
17 Between (5)
18 Music in which the listener can discern definite keys (5)
19 Diplomatic office lower than an embassy (9)
20 Inhabitants of an autonomous country within the realm of Denmark almost completely covered in ice (12)
24 Semicircular recess, often domed or vaulted, forming the eastern termination of a church (4)
25 Abrasive solids on which knives may be sharpened (10)
26 Organism harbouring a parasite or commensal (4)
27 Foreshadowed (10)

DOWN

1 Periglacial solifluction deposit (4)
2 Saami (4)
3 Suess's term for the great southern megaconinent that, Wegener realised, formed one lobe of Pangaea (12)
4 Hadean, Archaean, Proterozoic and Phanerozoic (5)
5 Raising to the Peerage (9)
7 Breath, from a fumarole, for example (10)
8 NASA Orbiter Vehicle OV-101 (10)
11 Author of the dialogue for a film (12)
13 Should, strictly, be the name of a camera, but actually used to describe its product (10)
14 One who transcribes the inspirations of another. Eric Fenby, for example (10)
16 Let loose (9)
21 Geodetic Reference from which levels are measured (5)
22 Single entity (4)
23 'Previously enjoyed' (4)

WIN A SPECIAL PUBLICATION!

The winner of the April Crossword puzzle prize draw was Simon Quinn of London, UK.

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 - June 22**.

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 .....

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SOLUTIONS APRIL

ACROSS:
1 Concretion **6** Ibis **9** Abyssinian **10** Ergo
12 Precognition **15** Bronchium **17** Rigor
18 Eosin **19** Tenebrous **20** Trephination **24** Veto
25 Signboards **26** Sash **27** Synonymous

DOWN:
1 Coal **2** Nays **3** Rostroconchs **4** Tonic
5 Orangemen **7** Burlington **8** Spoonerism
11 Microbiology **13** Objectives **14** Conspectus
16 Intensity **21** Tango **22** Brio **23** Isis

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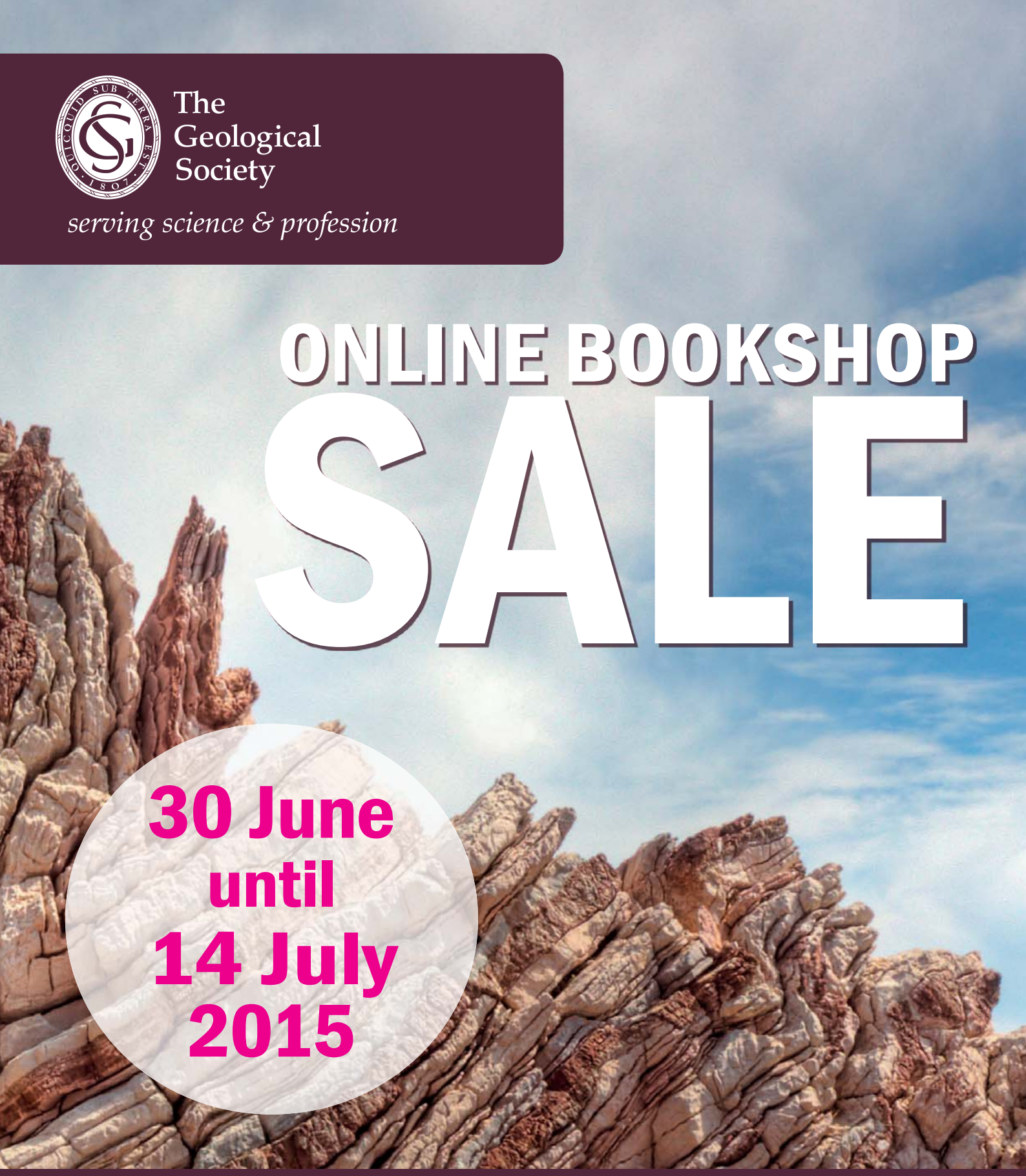

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