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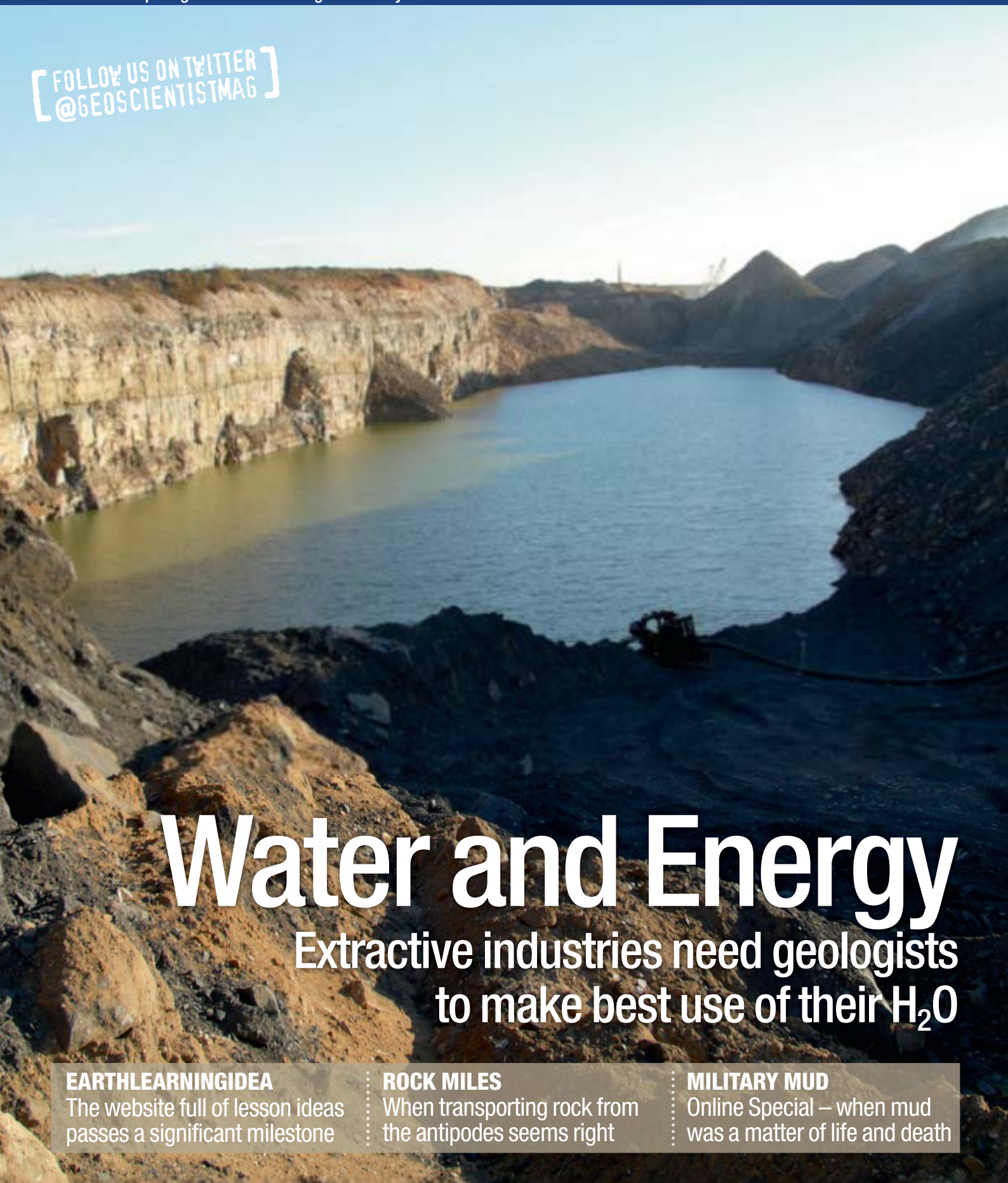

Water and Energy

Extractive industries need geologists to make best use of their H_2O

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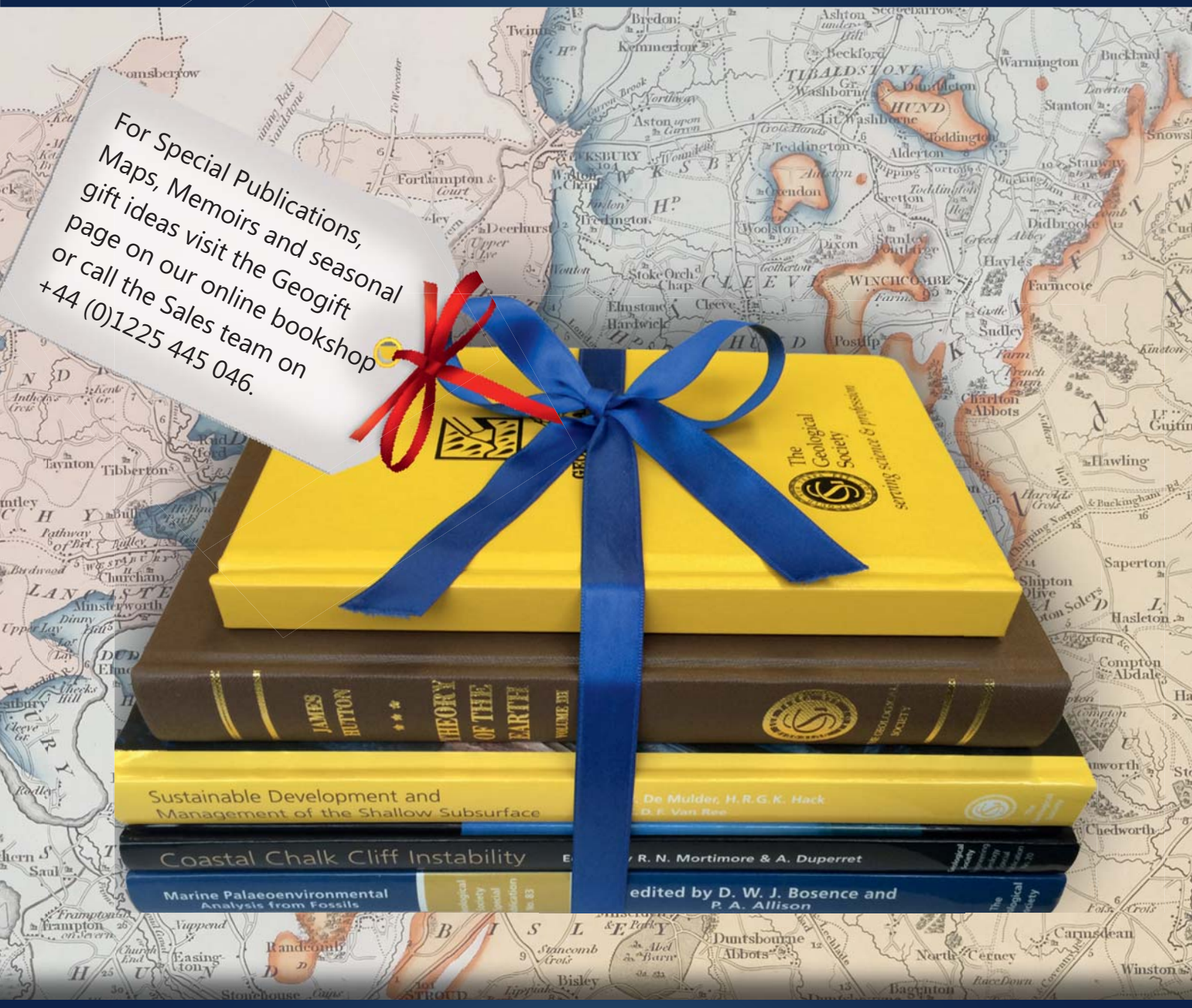

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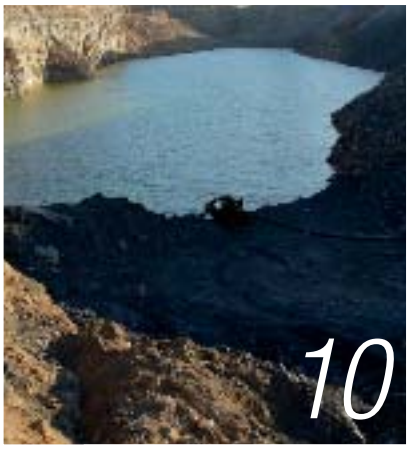

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10 Water & Energy

To make best use of the Earth's most vital commodity, extractive industries need geologists, writes John Simmons

ONLINE SPECIALS

1944 – When Mud was a Military Matter
Dave Greenwood looks back to a time when mud was a matter of life and death.

FEATURES

REGULARS


FESTIVAL OF GEOLOGY
Saturday 7th November 2015
ENTRANCE FREE
10.30 am — 4.30 pm
University College London, Gower Street, London WC1E 6BT
Exhibitors from the World of Geology
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Walks and Field Trips
Amateur Photographic Competition
ROCKWATCH
UCL
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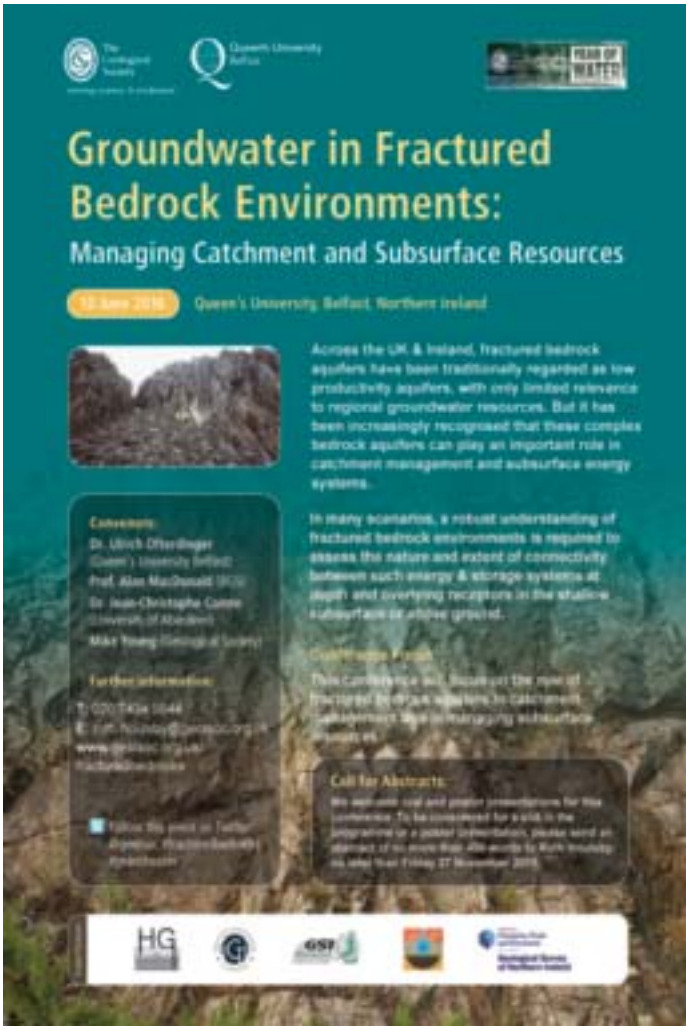
Groundwater in Fractured Bedrock Environments:
Managing Catchment and Subsurface Resources
Queen's University, Belfast, Northern Ireland
Across the UK & Ireland, fractured bedrock aquifers have been traditionally regarded as low productivity aquifers, with only limited relevance to regional groundwater resources. But it has been increasingly recognised that these complex bedrock aquifers can play an important role in catchment management and subsurface energy systems.
In many scenarios, a robust understanding of fractured bedrock environments is required to assess the nature and extent of connectivity between such energy & storage systems at depth and overlying receptors in the shallow subsurface or active ground.
Call for Abstracts


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> THE OIL AND GAS BUSINESS SPENDS HUGE AMOUNTS OF TIME AND MONEY PUMPING THE STUFF. NO SURPRISE THEN THAT THOSE OPPOSED TO FRACKING TALK MAINLY ABOUT WATER

Front cover image: © MarcelClemens/GeologicalSociety

FROM THE EDITOR'S DESK:

Water wars

We have, sadly, grown used to the idea of nations warring over sources of energy. But as this week's main feature points out, the oil and gas business (now more than ever, with the advent of fracking technologies) spends a huge amount of time and money pumping - water. No surprise, then, that most of the (overtly expressed) opposition to fracking concerns itself with water-related issues.

However, water – especially fresh water - is itself scarce in many parts of the world, and many of those 'water-stressed' nations are also where other natural resources are increasingly being extracted. The demand for water in producing raw materials and energy cannot but exacerbate an already pressing problem. Ten of the world's most 'water-stressed' nations (see map, page 12) are located in the Middle East.

Violence and tension over water is nothing new, and it is on the rise. Peter Gleick is President of the Pacific Institute, an independent US research centre that publishes a chronology of water-related conflicts. "We see thousands of years of examples where water has been a source of tension in one form or another … violence related to water is growing, not shrinking", he says. Climate change, growing population, increasing living standards and industrial demand cannot help but drive the trend inexorably in one direction.

Business cannot ignore this – it is hardly in its interest to do so. The public cares about water in a way that it should do (but sadly doesn't) about energy. As usual with natural resources, the solution lies in providing businesses with a level playing field through sound regulation. Governments need to establish clear and transparent regulatory frameworks, so that all businesses can budget for water resource management. This also implies effective enforcement, which must be transnational if it is to be effective – as transnational as businesses themselves.

However, this need for internationalism does not absolve national governments. Unrest is most likely where there are corrupt, inadequate or ineffective regimes. As Gleick has argued: "The greatest risks of conflicts over water are not really at the intersection of the corporate sector and the water world. They are in regions where water is scarce and governments are not addressing how to allocate water fairly and effectively."

It is a familiar sentiment, but effective governance, informed by sound Earth science advice, once again offers our only hope of a solution.

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

FELLOWSHIP **ELECTION**

The following are put forward for election to fellowship at the OGM on 25 November 2015:

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

SOCIETY*NEWS*

CGeol Overseas – a HK Perspective


Image: DaisPicks/shutterstock.com

Stuart Millis reflects on the steady growth in the importance of Chartered Geologist Status in Hong Kong.

Anyone who's worked in Hong Kong won't have failed to notice the local love of business cards and the desire for collecting qualifications to print on them. It will come as no surprise to most then that the CGeol qualification is currently flourishing in Hong Kong, with between five to 10 new applicants each year and over 85 Chartered Geologists registering Hong Kong as their base of operation. What may surprise you though is how much time and effort has gone into reaching a situation where CGeol is seen as having parity with the professional qualifications obtained by our engineering brethren.

Dam

The modern era of geotechnical engineering/engineering geology in HK (the field in which c. 90% of HK geologists operate) essentially kicked off in the late 1970s with the establishment of the Geotechnical Control Office in HK Government, now known as the Geotechnical Engineering Office (GEO). The need arose because of a number of major landslides in 1972 and 1976 required Government action. Before this, significant inputs occurred in a more piecemeal manner with contributions to numerous major civil engineering projects and in particular the High Island Dam project.

With the creation of the GEO, a number of major slope safety initiatives resulted in the elevation of the role and need for geologists. In 1978-9, visionary applications of engineering geological/geomorphological mapping resulted in definition of the Mid Levels Moratorium for Building Development (May 1979). The Moratorium was implemented because of slope safety concerns over multi-storey re-development in one the most expensive pieces of real estate in the world (at the time).

This led to such seminal projects as the Mid Levels Study, the terrain classification-based Geotechnical Area Studies Programme (1979-1989), remapping the geology of HK and the creation of a permanent 'Geological Survey of HK' (1982). These all contributed to raising our profile and an influx of geologists.

The significance of sound geological input to projects was well recognised at the time, with engineering geologists filling senior positions in both Government engineering bodies and private consultancies. With Government support, a positive environment was created for public and private sector geologists to interact with those in the education sector - as shown by the formation of the Geological Society of Hong Kong in 1981. A GEO-led scheme to train engineering geological graduates was up and running by the mid 1980s, and highlighted the need for sound training and integration of skills. It also put pressure on academia for HK-based undergraduate courses, as the trainees were then all educated overseas.

Slope safety

With the increasing rate of development, geologists were not only involved in numerous slope-safety studies and a wealth of civil engineering and development projects, but also helped drive government policy on major livelihood

issues of the day - including the need to re-house some 300,000 squatters on landslide-prone hillsides in 1983, and floodplain management after severe flooding (1987). Geologists were also deployed in the Housing Department to assist with major housing construction. In the late 1980s and early 1990s, geologists were instrumental in advancing the concept of 'cavern' development and contributed to pioneering work in management of fill supply, and contaminated mud disposal for a range of reclamation projects - including the new airport at Chek Lap Kok.

However, these were generally 'pre-CGeol' days, and many geologists had to establish themselves either by perseverance and reputation or by obtaining engineering qualifications through the Geotechnical Discipline of the Hong Kong Institution of Engineers (HKIE). Some were able to qualify for CEng through the IMMM. In the early 1990s, only a handful of Geologists held Chartered status.

Declining workloads in the late-1990s (following the completion of Chek Lap Kok Airport and associated infrastructure) together with the knock-on impacts of the Asian Financial Crisis seemed to trigger a shift in the status of geologists in Hong Kong, with geotechnical departments of many companies becoming reliant on the Government's Landslip Preventive Measures (LPM) Programme – geologists' roles often being limited to supervision of ground investigation works, cutting geological sections and (with an enlightened employer) the odd bit of slope stability analysis and stabilisation design.

Balance

A number of (largely successful) measures were taken by the geological community in the late 90s and early 2000s to redress the balance. These included the establishment of the first local Earth science undergraduate course (1995) after almost 10 years of effort (which is now GSL-accredited, we're happy to say!) the formation of the Hong Kong Regional Group (the first and only overseas Regional Group of the GSL, 2001); a push within Government and Consultancies for CGeol to be afforded equal status to engineering qualifications; the establishment of a 'Resident Geologist' role for supervision on projects where ground conditions played a major part (with CGeol as the defined required qualification for the position), and the specification of CGeol staffing requirements for tendering of some government projects.

Overall, these efforts have been very successful and geologists in Hong Kong have enjoyed an increasingly prominent role in the conceptualisation, design and delivery of numerous major projects. Much credit should also be given to the impact of Company Accredited CGeol Training Programmes, which have been expanding rapidly in Hong Kong. This has done much to lift the profile of geologists within corporate structures and is proving very attractive to young graduates.

With increasing focus on geohazard assessment and underground engineering, it looks like the future for Chartered geologists remains bright.

***Stuart Millis,** Chair, Hong Kong Regional Group

The Geological Society Club

Image: Chrisdorney / Shutterstock.com

The Geological Society Club, successor to the body that gave birth to the Society in 1807, meets monthly (except over the field season!) at 18.30 for 19.00 in the Athenaeum Club, Pall Mall, or at another venue, to be confirmed nearer the date. Once a year there is also a buffet dinner at Burlington House. New diners are always welcome, especially from among younger Fellows. Dinner costs £57 for a four-course meal, including coffee and port. There is a cash bar for the purchase of aperitifs and wine. Burlington House dinners include wine. Dates for 2016 will appear in a future issue.

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

FELLOWSHIP **ELECTION**

The following Candidate Fellows, who graduate this year, must upgrade to Fellowship within 12 months following graduation should they wish to continue with membership. Once applications are received their request will be forwarded for election at the next available OGM.

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Christmas is coming

Jenny Davey has some gift ideas for the rockhound in your life.

With the festive season almost upon us, the Geological Society Publishing House would like to remind you the last date for ordering in time for Christmas is **7 December 2015**, for UK and upgraded overseas deliveries (when choosing DHL or Air Parcel at checkout). Our great gift ideas start from as little as £7!

➤ To browse our collection of books, maps and DVDs visit **www.geolsoc.org.uk/geogifts**

FUTURE MEETINGS

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

Ordinary General Meetings:
- **2015:** 25 November
- **2016:** 3 February
- **2016:** 6 April

Meetings of Council:
- **2015:** 25 November
- **2016:** 3 February
- **2016:** 6 April

Research Funds

Applications are invited for the 2016 round of the Society research funds. Please complete the appropriate form which can be downloaded from the Society Awards and Research Grants page at **www.geolsoc.org.uk/grants** where you will also find information about the Society's funds and others administered by the Society. The average award has been about £1000.

The Research Grants committee meets once annually. Applications must reach the Society no later than **1 February 2016** and must be supported by two Fellows of the Society who must each complete a supporting statement form. Only complete applications on the appropriate form will be considered.

Please send to the Awards Secretary at the Geological Society.

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LONDON LECTURE SERIES

Landscape Dynamics, Erosion and Sedimentation

Speaker: Dr Alex Whittaker **Date:** 18 November

Programme

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

Further Information

Please visit **www.geolsoc.org.uk/shelllondonlectures15**. 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**

Towards a 'moral geology'

Edward James* believes the Society should further widen its remit and join with others to entertain novel perceptions

There is strong support to rename the current epoch in which we live as the 'Anthropocene'. But the new age needs far more than us. Our home is the whole Earth, and humans only a small, renegade, part of it. We depend completely on it, and carry responsibility to care for it.

However, the name 'Anthropocene' implies that we cannot separate the study and practice of traditional geology from other human activity. This implies a concern with the moral issues that confront us every day. Before long, the idea of doing any 'science' while ignoring moral aspects will be seen as outdated and incomplete at best, and certainly sadly destructive to quality of life.

Revolution

I believe that the Society should continue our Secretary's 'Quiet Revolution' (*Annual Review 2014*). Every member needs to be involved in widening the Society's remit. This is already happening, and is evident in the paper *Geology for Society*, where 'reaching out' is stressed.

But 'reaching out' means conversing with those 'outside'; which, if serious, implies that we need to scrutinise our personal objectives continually. And 'Moral Geology' involves making moral decisions on what we each do geologically.

I was for some years responsible for a website that displayed all activities connected with Carbon Capture and Storage (CCS) worldwide. This task was later taken over by the Australian government, which wants CCS to work (mainly for political reasons). But my own technical experience of CCS projects suggests to me that they will not succeed. My only solution to this is that we should not take any more oil out of the ground. Widening remit means entertaining new perceptions. For example, I feel (as a mathematician) that rational logic cannot provide answers to moral problems. We can only do our best, in the time available, with limited data.

Fourteen years ago, our former Executive Secretary made a far-sighted arrangement to accept Society membership applications from a group concerned with the Earth as a single complex system. And so the Earth Systems Science Group of the Society came into existence. Its members are dedicated to the Earth and its future development, but not necessarily working within traditional Earth Sciences.

Onlookers

Since then the group has held conventional meetings, but has also pioneered small meetings in which people in widely different spheres of expertise can meet together and consider the wider implications of Earth System Science. We have no vaguely interested onlookers at these: each invitee is a specialist in their own right - even practising geologists! But they have to be open to new ideas outside their specialism, and able to work to build a new synthesis. Clearly those with compartmented views on what 'Geology' should be would find this difficult. But we must face such difficulties.

I would suggest that similar wide-ranging meetings could be promoted in all other areas of the Society. We must interest and involve prominent thinkers from 'outside' classic Geology to help us.

◆ **For more on this topic, see Books & Arts, p22**

***Edward James** is an independent scientist with a background in mathematics and computing. For further information, or to contact him about this article, please visit www.edward-james.net/

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 NAME 'ANTHROPOCENE' IMPLIES THAT WE CANNOT SEPARATE THE STUDY AND PRACTICE OF TRADITIONAL GEOLOGY FROM OTHER HUMAN ACTIVITY"
> Edward James

WATER IN THE ENERGY INDUSTRY

Image: All photos, John Simmons

Geologists in the energy industry can improve their company's financial performance, environmental impact and engagement by reviewing their involvement with water, **writes John Simmons***

In the increasingly vibrant debate about the effect of energy production on the environment, the focus has been largely on anthropogenic CO_2 and the need to leave hydrocarbons in the ground. While that debate rages in forums at national and international level, another aspect of energy production, with a significant effect locally and regionally, attracts far less attention.

Water is critical in the extraction of coal, gas, oil, uranium and geothermal energy. That involvement is widely misunderstood, seldom measured or reported correctly, and rarely optimised. As the competition for limited water resources and the need to protect catchment areas increase, along with growing pressure from the public and media, these factors pose a growing risk the continued sustainability of extractive operations.

'Sustainability' of an industry depends on recognising risk and, in order to do that, facts are essential - gathered from research, set in a logical context, and tested for their veracity and relevance to real-world settings. Gathering such data lay at the heart of a BP initiative begun in 2010 and still continuing today, known as the Energy Sustainability Challenge (ESC). The initiative was driven by Professor Ellen Williams, then BP Chief Scientist. She wrote:

"The ESC's aim is to gather facts and organise them in ways that can be accessed readily by policymakers. With water there were particular challenges; understanding the language around water use, appreciating the different ways in which volumes are measured and recorded and making reasonable extrapolations from the data available in developed countries to take account of data gaps in less developed nations"

***Above:** Water in open pit coal mine - source of supply to treatment plant for municipal supply*

> WATER IS CRITICAL IN THE EXTRACTION OF COAL, GAS, OIL, URANIUM AND GEOTHERMAL ENERGY. THAT INVOLVEMENT IS WIDELY MISUNDERSTOOD, SELDOM MEASURED OR REPORTED CORRECTLY, AND RARELY OPTIMIZED

Tanker supplying water to seismic crew in Algerian Sahara from source 250kms

Hydraulic fracturing pumps, Patagonia

The 26,000-ton, 610-foot-long plant was designed to treat 2 million barrels of seawater daily, for injection into the Prudhoe Bay reservoir to maintain pressure and enhance production

The results of the initiative, which involved researchers at 13 universities, are the publication of numerous peer-reviewed papers on a variety of topics and the production of three new handbooks, including '*Water in the energy industry – An introduction*' a freely available text from which the tables and graphs in this article are all taken[1].

The book is aimed at providing an introduction to many aspects of water across the energy industry, and geologists will find many familiar concepts described. I hope the book will cause individuals from many professions to examine water use in their workplace and be motivated to take positive action. Geologists across the extractive industries have the opportunity to use their skills and experience to minimise their impact on water. By examining water use across exploration and production it is, in many cases, possible to reduce both capital and operational expenditure. In some operations there may even be opportunities to increase the energy produced significantly.

Choice words

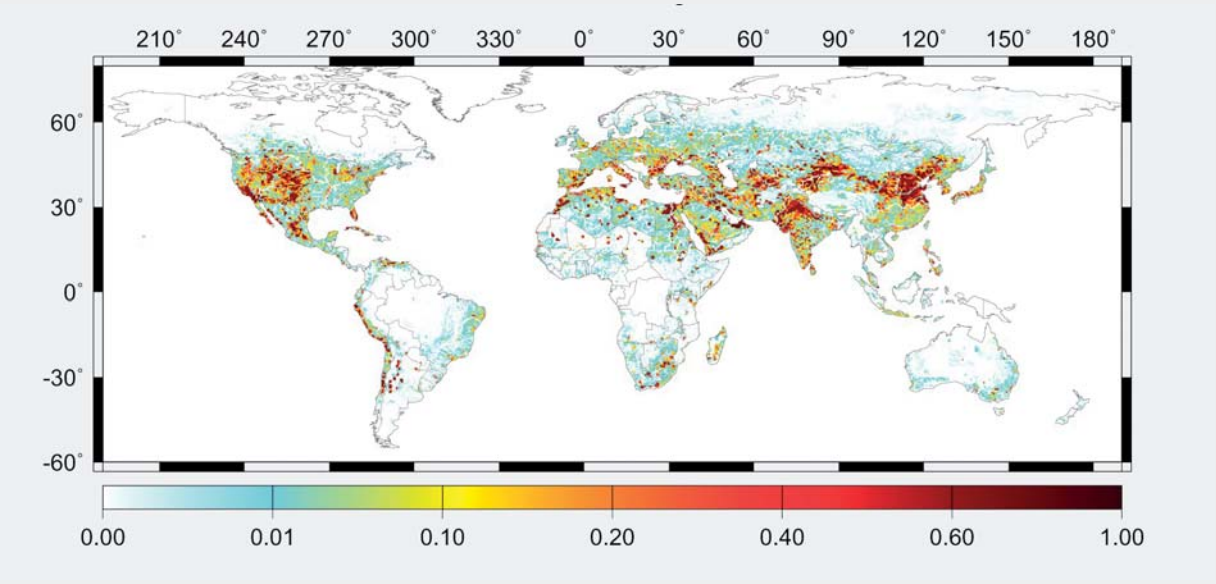
The first step towards understanding water's role in the energy sector is to clarify our language. When referring to water, the media regularly offer statements such as: 'On average, a vegan indirectly consumes nearly 600 gallons of water per day less than a person who eats the average American diet' or 'A gallon of gasoline takes nearly 13 gallons of water to produce'[2].

These sorts of statements are woven into many debates about water and combining 'statistics' with the misuse of verbs such as 'consume' and 'takes', results in chronic misinformation that negatively influences the development of onshore oil and gas and other energy projects. Unfortunate choice of language lies at the heart of the hydraulic fracturing debate, where statements such as, 'Oil and natural gas fracking, on average, uses more than 28 times the water it did 15 years ago, gulping up to 9.6 million gallons of water per well and putting farming and drinking sources at risk in arid states, especially during drought.'[3]

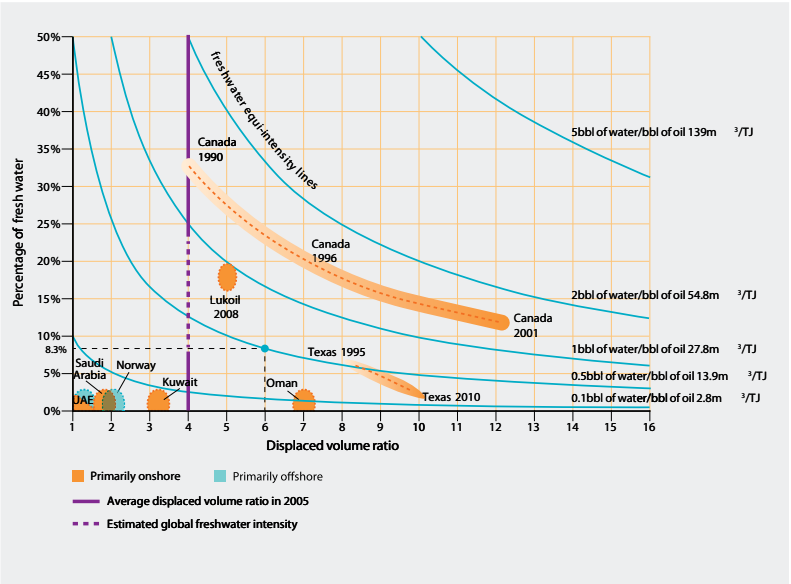
In an attempt to provide clarity, we decided to offer the following definitions. If widespread agreement on such definitions could be gained, understanding of water in industry would improve (and that quote from Scientific American would be a lot different). The volume of water consumed is vastly different, in most cases, from that 'gulped'.

Water use: the non-technical understanding is quite different from the engineering definition. In engineering, the same water can serve several functions in a process, and each will be counted as a ▶

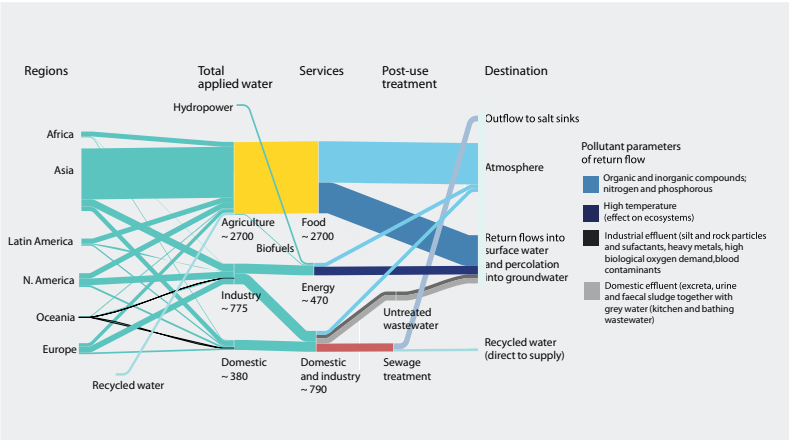
Global water scarcity indicated on a scale of 0 – 1. Regions with an index of 0.4 or greater are considered to be highly water stressed[6]



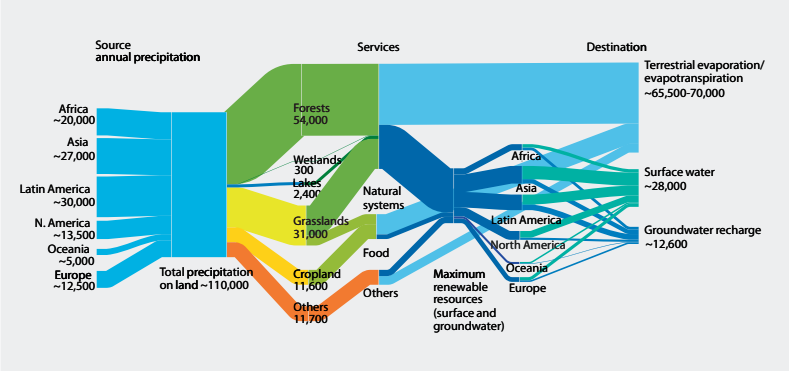
Freshwater consumption in conventional oil production for different regions and at different stages of field maturity. X - the ratio of total displaced volume (oil plus water) to oil produced. Y - percentage of injection water that is fresh. Solid curved lines - representative values of constant freshwater intensity ranging from 2.8m³/TJ to 139m³/TJ. Solid symbols show field conditions for UAE, Saudi Arabia, Kuwait, Oman, offshore Norway, Lukoil, Canada and Texas



Global freshwater Sankey diagram for annual precipitation over land. The vertical width of each bar in the diagram is proportional to the volume of fresh water involved, measured in cubic kilometres (km³), and numerical amounts are provided with labels, also in km³. Polar regions not included[5]



Global Sankey diagram for annual water withdrawn for human use[5]. Continental distribution of withdrawals, sectors (agriculture, industry, domestic), services provided by the water, and return of water to the hydrological cycle. Changes in quality during use are indicated (colours). Red indicates energy used in wastewater treatment



'use'. As a result the amount of water used in the engineering sense can be many times larger than the amount of water withdrawn.

Water withdrawal: water extracted from a source, at least temporarily, for use including domestic, industrial, energy-related or agricultural use. Water withdrawals are classified as either surface (from rivers, lakes or reservoirs) or groundwater withdrawals. Withdrawn water may be returned to the source, recycled, evaporated to atmosphere, disposed in a storage site for contaminated water, or embodied in a product, so water withdrawal is not necessarily the same as water consumption.

Consumed water: consumption is the portion of withdrawn water not returned to the surface or groundwater in the same drainage basin from which it was abstracted. Consumed water is evaporated, transpired, incorporated into products or crops, or otherwise removed.

Fresh water: commonly used term to distinguish river water from brackish or seawater. Definitions vary, but fresh water generally has total dissolved solids (TDS) of less than 1000 mg/litre[1]. This definition does not take into account other contaminants such as organic chemicals (see 'Water quality').

Reused water: used water and wastewater that is used again before discharge for final treatment and/or discharge to the environment. Reused water includes wastewater used for irrigation within a facility boundary. It also includes harvesting of rainwater within a facility boundary.

Recycled water: water that undergoes significant treatment (to reduce salinity and/or other contaminants), such that its quality is sufficient for other uses requiring fresh or near-fresh water.

Chalk and cheese

One of the challenges faced in writing the book was how to compare water use across the range of energy industries. We chose to consider the volume of water used per unit of energy - expressed in cubic metres of water per Terrajoule of energy – or m^3/TJ. This measure can be applied to the production of primary fuels, to the generation of electricity and also, for comparison, to the production of food calorie production, using irrigation. The reported numbers, shown below, make interesting reading and potentially useful arguments for inclusion in debates on sustainability.

So - how much water does the energy industry use? A group of researchers at the University of Cambridge have calculated that 470km^3 of fresh water are withdrawn annually by the energy sector. Ultimately, this is either returned to the hydrological cycle, evaporated or exposed to various levels of contaminants and post-use treatment.

To place that volume in context, it is necessary to examine the availability of freshwater for human use. Over 96% of the water in the hydrosphere is contained in the oceans. Of the remainder, most is found in permanent ice caps, glaciers and saline aquifers. Less than 1% of the total is in fresh groundwater, and the water that we normally think of as being easily accessible – rivers and lakes - constitutes only 0.01% of the water on Earth.

Of course the hydrosphere is dynamic, with a significant percentage of the water it contains in constant motion, driven by energy from the sun and resulting in annual global precipitation estimated at 111,000km^3. As the Sankey diagram from the Cambridge researchers indicates, with most of that precipitation returning to the atmosphere through evaporation and transpiration, the volume remaining to recharge groundwater and fill surface water systems, known, as the renewable freshwater resource (RFWR) is about 40,000 km^3. That volume is available to support the world's aquatic ecosystems and, at the same time, is the water that can fulfil human demands. A second Sankey diagram indicates the end uses of water withdrawn by humans.

If all of this available water were evenly distributed, extraction problems would potentially still exist. However, in reality, availability varies widely. A metric known as the water scarcity index, or WSI, can be used to illustrate this – see map.

TABLE 1

Energy Type	Water impact	Scale of water intensity (not necessarily all fresh water)
Fuel production (primary energy)	Consumption	Tens of M^3/TJ_t
Electrical generation	Consumption withdrawal	Hundreds of M^3/TJ_e Tens of thousands of M^3/TJ_e
Food Calories (agriculture)	Consumption of irrigation	Up to a Hundred Thousand M^3/TJ_c

TABLE 2.1 Freshwater consumption intensities reported for coal production in China and Australia's Bowen Basin. Water consumption is shown as an intensity in m^3/TJ and as a ratio in m^3/tonne. The results come from both surface and underground mining.

	Location/report	M^3/tonne	M^3/TJ	Process	Notes
China [45]	Shanxi Province	0.25 - 0.30	9.40 - 11.28	Underground mining	About 22% of chinese operations reuse mine water, and about 43% of the coal is washed
	China average	0.06 - 1.6	2.3 - 61	95% underground mining	
		0 - 0.2	0 - 7.52	Dry-wet coal preperation	
Australia [51]	Bowen Basin coal mines	0*	0*	Surface mining*	The freshwater use represents 15-49% of the total water use among seven different mines, and includes rainwater captured on the site.
		0.15	5.54	Mixed surface and underground mining	
		0.13	5.54	Underground mining	
		0.15	5.61	Coal Preperation	

Note: conversion assumption one tonne of coal = 26.6GJ.
*Freshwater consumption in this example is zero becaus the source is non-fresh.

TABLE 2.2 Freshwater consumption intensities reported for uranium mining and ore benefication. Water consumption is shown as an intensity in m^3/tonne and in m^3/TJ_t, as well as total annual water consumption for the three main mining types [2,58]

Mining type	Portion of total uranium mined (2010) [2]	Freshwater consumption		2010 water consumption million m^{3**}
		m^3/tonne natural uranium metal	m^3/TJ_t*	
Open pit	23%	760	1.45	9.5
Underground	32%	1,770	3.39	31
ISL	39%	250	0.480	5.3

Note: Percentage of uranium mined does not total 100, because 6% of today's uranium originates as by-products of nun-uranium mines.
*TJt-terajoules of thermal energy. Different nuclear plants have different conversion effiencies.
Here the conversion factor used for thermal energy per equivalent tonne of natural U metal (non-enriched) is 0.52TJ_t/kg uranium metal.

**Based on a total of 54,670 tonnes natural uranium mined.
The remainder of the uranium used in electricity generation in 2010 was provided from secondary sources, such as by-products from other metal-mining operations, plus recycled nuclear materials.

TABLE 2.3 Estimates of consumption intensities and corresponding annual global water consumption for different primary energy sources. For each energy source, the proportion of primary energy is shown as a percentage and in TJ. The intensities are high-end estimates enabling calculation of high-end value of the annual freshwater consumption volumes, which total 9km^3. The notes indicate the data source from within the chapter.

Energy source	Share of world's primary energy produced (IEA, 2010 data)		Global Average consumptive water intensity	Annual freshwater consumption	Notes
	%	Million TJ	Million TJ	M^3/TJ	
Conventional oil	30.7%	145.0	15	2.18	Figure 2.8 and Table 2.1
Unconventional oil	1.7%	8.28	100	0.83	Tables 2.2 and 2.3
Conventional natural gas	18.3%	78.6	<1	0.08	See conventional gas, volumes of water section
Unconventional natural gas	2.6%	13.1	17	0.25	See unconventional gas, volumes of water section
Coal	27.3%	137.0	40	5.50	See coal, volumes of water section
Uranium mining and processing	5.7%	28.5	2.5	0.07	Tables 2.7 and 2.8
World		500.0		8.9	

Note: 1km^3 = 1 billion m^3

▶ **Water scarcity index (WSI) = Annual freshwater withdrawal / Local renewable freshwater resource (RFWR)**

It is implicit from the map of Global Water Stress that in areas of water stress, the withdrawal of any large volumes of water causes problems, especially for uses other than human consumption. As illustrated in the Sankey diagram, the Cambridge University group estimated that some 12% of human withdrawals (or 470 km^3) are destined for the energy sector.

Comparing the scarcity map with the locations of energy production gives one indication of the challenges facing energy producers. The 12% figure includes water used for cooling in electricity generation (possibly over half of the total) and therefore not usually the responsibility of the geological community. The remainder is a volume that can be affected by decisions made by geologists.

Mined energy

In simplistic terms, withdrawn water volumes in exploration for energy minerals are minute - just water for drilling fluids and that actually 'gulped' by the explorers. In coal mining, machine cooling and dust suppression need relatively small volumes and fresh water is not needed. Coal washing uses significant volumes, but most can be recycled.

A similar picture to that for coal emerges for conventional uranium mining, with machine cooling and dust suppression requirements (the latter even more significant than in coal mines). *In situ* leaching (ISL) process naturally has different requirements. Fortunately, in most ISL mining operations, groundwater - often already containing significant uranium - is used as the basis for the leach solution. Water use in ore processing varies considerably, 'heap leaching' using far more than the conventional crushing, milling and leaching process. Conversion and enrichment did, in the past, demand considerable volumes, but the phasing out of the gaseous diffusion method in 2013 has greatly reduced water demand.

Dealing with wastewater is a major challenge for the mining industry, particularly in uranium mining. Although recycling is used as extensively as possible in many mines, some water has to be disposed of - often in old workings or, in arid regions, by evaporation. Novel schemes have been pioneered by some mining companies in areas of water stress to treat coalmine water for human consumption. Any water that has come in contact with uranium minerals has to be disposed of, again in old workings, by evaporation or in specially drilled disposal wells.

Oil

As mentioned above, water-use in exploration is small and the same applies in the primary phase of conventional oil production. 'Produced water' reaching the surface is separated and either re-injected to help maintain reservoir pressure, disposed of via injection wells, or treated for disposal by other means. However, as soon as reservoir pressure drops to levels below economically sustainable rates, secondary production - usually involving waterflood - begins. If most of produced water is re-injected, then the volume of additional water required will be roughly equal to the volume of oil produced.

A wide variety of water qualities have been used for waterflood - ranging from seawater to the outflow from sewage treatment works! As any water that is injected will be affected by the chemistry of the reservoir, it can be assumed to take on the characteristics of produced water. Such water cannot be returned to the catchment area without considerable treatment, so it can be thought of as being

Labourer on seismic crew in Algerian Sahara

Water for drilling mud, Oman

'consumed'. The volume of freshwater thus consumed will depend primarily on the volume of produced oil and the fraction of re-injected water that is fresh. As alternatives to freshwater are increasingly being employed, the percentage used for injection is decreasing – see graph.

Gas

Waterflood techniques are not used in conventional gas production so the volumes of freshwater consumed are limited to that supplied for drilling muds. However, as soon as hydraulic fracturing is employed to produce gas from tight sands or shale, then the availability of water becomes critical to operations. This is what lies at the heart of public apprehension about this technique.

Much progress has been made in the last few years in the use of recycling, to minimise the need for freshwater and also the use of lower-quality water is increasing. Volumes vary widely, depending on the type of fluid system employed and the percentage of water that returns to surface as flowback. The latter parameter varies from well to well - mainly influenced, it is thought, by the lithology of the fractured unit. This variation is shown in the graph below where water intensity is plotted against estimated ultimate recovery of gas from 400 wells in the Barnett shale of Texas.

Until a well stops producing, it is impossible to accurately calculate the water intensity so the graph below is produced for three of the largest shale plays in the USA using estimates of the ultimate recovery.

Intensity comparisons

We were able to construct a table that allowed us to compare the water intensity for different primary energy sources - (Tables 2.1-2.3).

The wide variation in water intensity illustrated in that table serves as a further prompt for everybody in the energy industry – geologists especially – to consider what can be done to reduce water consumption. The book stresses four Rs: Replacement with non-freshwater, Reuse of water in processes, Recycling, and Regional responsibility - which calls for the adaption of practices to best suit local conditions.

Any reduction in water intensity has the potential to reduce costs, improve the environment, improve public engagement and the licence to operate. By definition, geologists can play a leading role in guiding such reductions.

Much is written in the book about water in the energy industry. However little is said about the energy *contained* in the water. Hundreds of millions of barrels of water are produced in oilfields daily, most of it at temperatures well above ambient. The energy held within this hot water is vast and, at the time of writing, little is captured. ◆

* **John Simmons,** CGeol FGS, Principal Adviser, RPS Energy and Director, ON Communication

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Reverse Osmosis plant in South Africa used to transform coalmine waste water into water fit for the municipal supply

EARTHLEARNINGIDEA

FOR GEOSCIENCE EDUCATORS EVERYWHERE

Image: Elizabeth Devon

Earthlearningidea, a website for geoscience educators, recorded its first two million activity downloads this year, **writes Chris King***

Little did we realise, when a bid for funding from the UN International Year of Planet Earth was turned down, that such a successful phoenix could arise from the ashes. It led us to wonder what else we could do during the International Year - without funding - and we developed the idea of publishing one new geoscience education activity, online, in each of its weeks. Thus, during the year, three of us (working on a voluntary basis) published 52 Earth-science teaching activities, aimed at teachers and classrooms with minimal resources, since our initial target audience was teachers in the developing world. This was so successful that we have continued to publish activities (at the rate of one every two weeks) ever since.

During the International Year (2007, though like all things geological, the UN Year actually lasted longer than that, from 2006 to 2008), a colleague from Argentina asked if he could translate the activities into Spanish. We welcomed this, and thus Spanish Earthlearningideas were added to the website. This was the beginning of the Earthlearningidea translations which followed. (Stop press: A Danish colleague has just offered to translate Earthlearningideas into Danish and Greenlandic (the Eskimo–Aleut language spoken by about 57,000 Greenlandic Inuit people.)

Developed

It soon became clear that, despite our IYPE-inspired intention, most users of Earthlearningideas were living in the more developed world – and particularly the USA. So we decided to broaden our repertoire to include Earthlearningidea + ('ELI plus') activities, requiring either slightly more sophisticated equipment (as found in normal school science labs) or more abstract thinking than our original Earthlearningideas. Later we also added Earthlearningideas for teaching 'early years' pupils.

The success of Earthlearningidea can be summarised by these figures, from July 2015:

- 2,071,954 pdf downloads of Earthlearningideas so far (not including the separate websites set up to disseminate Earthlearningideas in different languages, such as Portuguese, German and Polish)
- 47,560 mean number of pdf downloads per month in 2015
- 212 Earthlearningidea activities published in English
- 607 translations from English by December 2014, into 10 other languages, Spanish, Catalan, Portuguese, Norwegian, Italian, German, Polish, South Korean and one in Tamil
- 25GB of download data per month
- 195 countries and 9669 cities and towns in which the Earthlearningidea blog has been accessed
- 10 top countries, in order:

- United States
- United Kingdom
- India
- Canada
- Spain
- Australia
- Italy
- Philippines
- Germany
- New Zealand

Each Earthlearningidea activity is published as a free-standing activity with supporting photographs and diagrams. The activity is followed by a 'Back up' section containing teaching information including the context in which the activity could be taught, the 'answers', underlying scientific principles, pupil learning outcomes, age range, timing and resource list, how thinking skills can be developed through the activity, follow-up work, useful links and the source of each idea.

Most ideas are practical 'hands-on' activities, but some are thought experiments, others are card sorts, some are aimed at fieldwork and so on. Many were originally published in Earth Science Teachers' Association (ESTA) publications or in Earth Science Education Unit (ESEU) workshops; but activities have also been culled from a wide range of resources, while others were especially devised for the website. ▶


Image: Elizabeth Devon


Image: Peter Kennett


Image: Jothi Rajan

***Above top:** Earthlearningideas as part of the 'Amazing planet - action-packed classroom science' presentation*
***Above middle:** Demonstrating isostatic rebound as the washers (ice) is removed*
***Above lower:** Earthlearningideas in use in India.*
***Left:** Testing pellet strength from the 'Make your own rock' Earthlearningidea*

> DURING THE INTERNATIONAL YEAR OF PLANET EARTH, WE PUBLISHED 52 EARTH SCIENCE TEACHING ACTIVITIES, AIMED AT TEACHERS AND CLASSROOMS WITH MINIMAL RESOURCES

Geobattleships Leeds

Image: Peter Kennett

Demonstrating hotspots – with a candle

The 'Washing line of time'

▶ Many people have contributed, and a further 50 activities are currently in preparation.

Success

To what can the unexpected success of an activity, initially generated by three people working on a voluntary basis, from their own homes be attributed? We don't know. This may seem counterintuitive, but it could be that there is great power in voluntary work. Since we receive no income, we can ask people across the world to publicise and use our work and even to translate the ideas, for exactly the same as we get paid ourselves, i.e. 'nothing'! Colleagues everywhere, particularly members of the International Geoscience Education Organisation (IGEO), have responded wonderfully positively - and it is surely no accident that Earthlearningidea is most successful in countries with active IGEO members.

Other reasons may be:

◆ By adding a new activity to the website each fortnight, with email alerts, generated through email, the ELI blog, Facebook and Twitter, people across the world are sent regular Earthlearningidea updates.

◆ Each activity is written in accessible English with simple resources, and so can be easily incorporated into teaching Schemes of Work.

◆ Many Earthlearningideas are deliberately innovative, presenting Earth science in dynamic, interesting and engaging ways that have the potential to fire the enthusiasm of teachers and pupils alike.

◆ An effective search engine ensures that ideas available for different topics are easily found on the website.

◆ Lists of 'Children's Fun Session' for use by any enthusiastic geologist in family days or in museums.

◆ Lists of activities for different teaching strategies.

Whatever the reasons, the year-on-year increase of pdf downloads clearly demonstrates Earthlearningidea's popularity across the world.

This initial bid to the International Year of Planet Earth for funding was to present UK-style Earth Science Education Unit workshops as professional development to teachers in certain countries around the world. The failure of that bid has caused Earthlearningideas to be used as the basis of teacher education workshops in many more countries around the world than originally envisaged – another unexpected bonus.

So, how can Geoscientist readers help? First, you can pass information about Earthlearningidea (http://www.earthlearningidea.com) to all the geoscience educators you know worldwide, as well as to science and geography teachers teaching Earth science topics. If you are running a family day or visiting a school to give a talk, please mine the Earthlearningidea website for ideas to give your presentation extra added oomph. If you have a simple idea of your own that you would like to share more widely, please let us know. If indeed it is suitable, we'll be happy to publish it as a future Earthlearningidea.

Earthlearningidea examples

◆ Fieldwork: the 'All powerful' strategy: discussing geological histories in imaginative ways

◆ Continental split – the opening of the Atlantic Ocean: modelling how the continents moved, from Pangaea to today

◆ Journey to the centre of the Earth – on a toilet roll: just how thin is the crust we live on?

◆ Sink hole!: demonstrate sink hole processes in action

◆ How many Beany Beetles? - the evolution game: investigating evolution by adaptation and natural selection

◆ A screaming roller coaster: How fast am I travelling (due to Earth's spin and Earth's orbit)?

◆ Smelter on a stick: smelting iron ore to iron on a gas burner

◆ Running the fossilisation film backwards: bringing a fossil 'back to life'


Image: Elizabeth Devon


Image: Peter Kennett

Plasticine spheres – which one has the core?


Image: Peter Kennett


Image: Elizabeth Devon

A smelter on a stick


Image: Peter Kennett

Imbrication dominoes

* **Chris King** (Keele University), with Peter Kennett and Elizabeth Devon.
E: info@earthlearningidea.com

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José Sellés Martínez - Argentina
Merethe Frøyland, Kari Beate Remmen and Anne Kristine Byhring - Norway
Roberto Greco, Barbara Scapellato, Claudio Casali, Bovino Miria, Sonia Manaresi, Giulia Realdon, Laura Agostini, Paola Fregni, Chiara Fioroni, Mauro Marchetti, Maddalena Macario, Lorenzo Lancellotti, Eleonora Paris and Nicoletta Scattolin - Italy
Dirk Felzmann, Julia Brinkmann, Florian Wetzel, Silke Rönnebeck, Sylvia Brink and Kai Frings – Germany
Celso Dal Ré Carneiro, Nádia C. M. Hoffman, Gustavo H. Teramatsu and Roberto Greco - Brazil
Xavier Juan – Spain and Catalonia
Pawel Wolniewicz - Poland
Shao Yanxiu, Zhang Lianhai and Julia Yuan – China
Michael Anjello Jothi Rajan - India

IUGS-COGE - International Union of Geological Sciences - Commission on Geoscience Education: for an unsolicited donation of US$1000 for the development of this project in 2008

Geologists' Association, Curry Fund for a grant to host the website on a dedicated server from July 2014

The Geological Society
serving science & profession

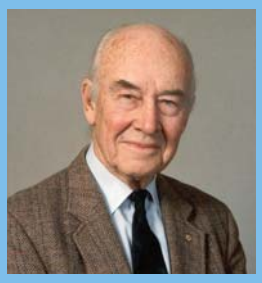
TSG

Arthur Holmes Meeting 2016

The Wilson Cycle: Plate Tectonics and Structural Inheritance During Continental Deformation

23-25 May 2016

The Geological Society of London, Burlington House, London, UK



This meeting will mark the fiftieth anniversary of Tuzo Wilson's landmark paper asking "Did the Atlantic close and then re-open?". This paper was one of a series of papers which led to the "Wilson Cycle" concept, in which the repeated opening and closing of ocean basins along old orogenic belts is a key process in the assembly and breakup of supercontinents. This implied that the processes of rifting and mountain building somehow pre-conditioned and weakened the lithosphere in these regions making them susceptible to strain localization during future deformation episodes.

It is now generally accepted that most geological architectures are controlled by interactions between plate motions, the horizontal mechanics of the lithosphere and pre-existing structures in the crust. However, our detailed understanding of the processes of structural inheritance is still very limited.

This 3-day meeting will therefore bring together geophysicists, structural geologists, and modellers in order to re-assess the legacy of the Wilson Cycle concept and how our understanding inheritance in continental tectonics has evolved over the past 50 years.

Preliminary confirmed Speakers include:

Kevin Burke (University of Houston, USA)

Celâl Şengör (Istanbul Technical University, Turkey)

Henry Halls (University of Toronto, Canada)

Philip England (University of Oxford, UK)

Shijie Zhong (University of Colorado, USA)

John Dewey (University of Oxford, UK)

Haakon Fossen (University of Bergen, Norway)

Andréa Tommasi (University of Montpellier, France)

Myra Keep (University of Western Australia)

Bob Holdsworth (Durham University, UK)

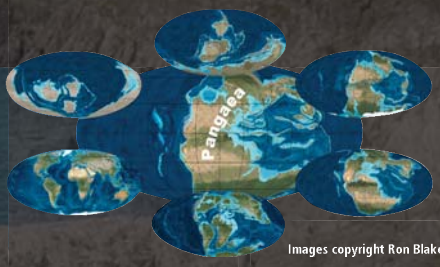
Robert Hall (Royal Holloway University, UK)

Erik Lundin (Statoil, Norway)

Sergey Drachev (ExxonMobil, UK)

Thematic sessions include:

- **The Wilson & Supercontinent cycles – how well do they work on a global scale?**
- **Lithosphere scale & deep earth dynamics**
- **Reactivation and reworking during the rifting, break-up and orogenesis**
- **Long-term weakening processes during continental deformation**
- **Regional themes & case studies**



Images copyright Ron Blakey

Field Trip

There will also be a four-day, post-conference field excursion to the *Scottish NW Highlands* to observe and discuss basement inheritance and reactivation processes in the field. This will take place from *Thursday 26 to Sunday 29 May 2016.*

Participants who would like to attend are encouraged to contact the conference organizers to register their interest, as places are likely to be limited.

Convenors

Woody Wilson (BP Exploration, UK)

Ken McCaffrey (Durham University, UK)

Tony Doré (Statoil [UK] Ltd, UK)

Greg Houseman (University of Leeds, UK)

Leigh (Wiki) Royden (Massachusetts Institute of Technology, USA)

Call for papers

We welcome both oral and poster presentation contributions from both surface and sub-surface settings for this meeting. *If you would like to submit a paper to the meeting, please send an abstract of no more than 400 words to Ruth Houlsby.* A Geological Society special publication is planned containing papers linked to presentations at the meeting. **E:** ruth.houlsby@geolsoc.org.uk

Abstract Submission Deadline: 18 December 2015

Further information:

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

T: 0207 434 9944

E: ruth.houlsby@geolsoc.org.uk

W: www.geolsoc.org.uk/ahm16

Follow this event on Twitter: @geolsoc #ahwilson16

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**

Chartership is very useful

Image:Shailith/ Shutterstock.com

Sir, I disagree with Rob Wallace's recent letter, questioning the practical benefits of Chartered Status (*Geoscientist* 25.8 p17). Within the aggregates sector of the UK minerals industry, Chartered status has long been seen as a 'benchmark' for achieving full career-level competency as a practising geologist. For our geologists it is a significant career milestone as we seek to develop an individual's competency and align it to career development.

In a practical sense we ensure that individual competencies around the various types of project completion and sign-off (including Reserves and Resources reporting) are developed in parallel to the more formal requirements of Chartership.

Thus the conferring of Chartered Status represents, in a very real sense, our confidence in a geologist's ability to operate within our organisation to a minimum level of technical supervision, but with the usual and appropriate mechanisms for peer review.

We are probably the largest employer of geologists within our sector and I believe that our practical approach to Chartership has served us well over the years. I understand that other organisations within our sector take a similar approach. In contrast to your correspondent I have noted a number of recruitment advertisements over the years which list CGeol as a requirement.

PAUL JOEL

CGeol hides my DIC

Sir, In complete contrast to Rob Wallace I have found the Chartership extremely useful. Firstly, my Chartered status gained me membership into Costco, which has approximately 88 million members and 700 outlets worldwide, offering significant discounts on thousands of products. I've also found it useful to draw one's eye away from my 'Diploma of the Imperial College' title ('DIC'), when applying for jobs and listing my postnominals (BSc, MSc, DIC, CGeol, FGS)!

JOHN LASOCKI

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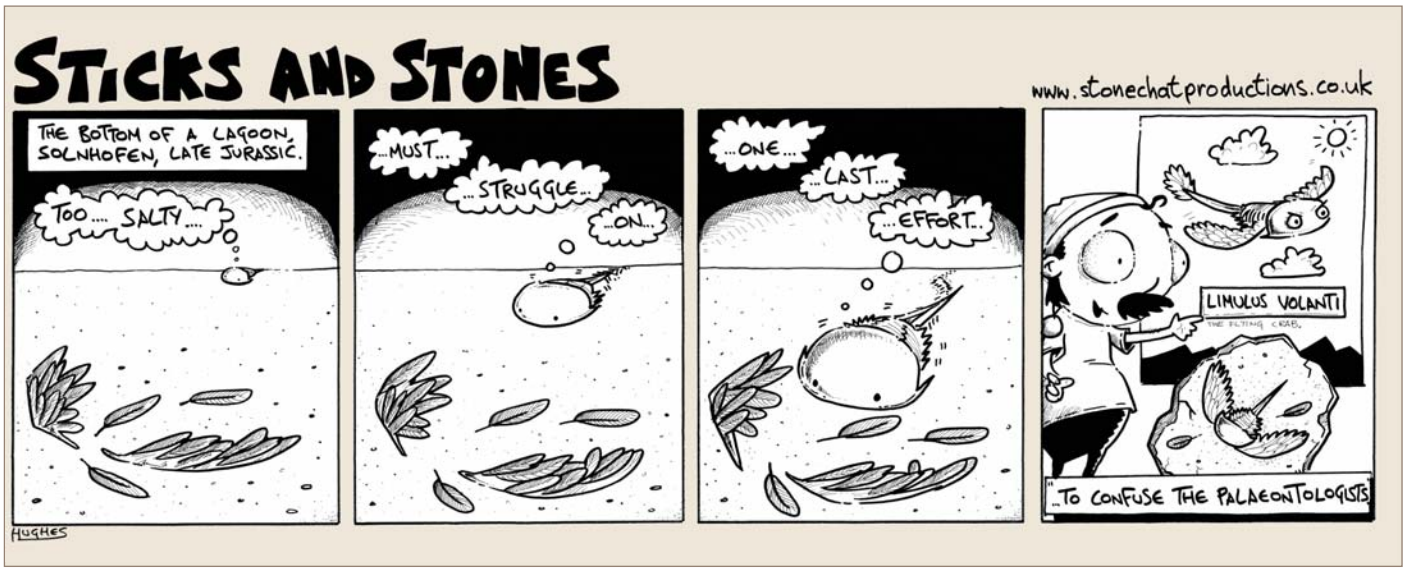
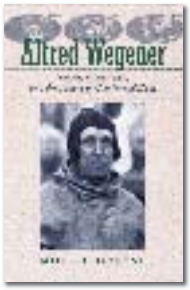


Alfred Wegener - Science, Exploration and the Theory of Continental Drift



There is a moment in *The Empire Strikes Back* (1980) that neatly encapsulates two contrasting scientific character types. Captain Piett reports a lead from one of many drones sent out to find a rebel hideout. Admiral Ozzel dismisses his claim with statistical objections, but Darth Vader takes one quick look and says: 'That's it – the rebels are there'. Such intuitive certainty characterised Alfred Wegener, subject of this brilliant and much-anticipated biography. Wegener saw what others missed, knew he was right - and mostly was. The Force was strong with him.

Wegener was born in Berlin, youngest of five, to Anna Schwarz (1847-1919) and Richard Wegener (1843-1917), clergyman, intellectual, poet, classicist and director of a school for orphans of worthy professionals. Hard work and outdoorsy asceticism marked his upbringing. Sharing his lifelong need for physical exertion with older brother and fellow explorer Kurt (1878-1964), Alfred developed a love of ballooning that led to their joint 1906 world continuous flight record (52.5 hours).

The tenor of his life thus set, throughout Alfred's three gruelling Greenland expeditions (graphically recounted here) his dogged pursuit of scientific data verged on superhuman. But the model for the theoretical work on which his legacy chiefly rests was set in 1909 when, in a paper on atmospheric layering, he advanced a theory based on data published by others - making connections overlooked by the original authors that led to more elegant conclusions.

This was exactly what happened in 1911, when Wegener made his wild surmise on first looking into Karl Andree's *Allgemeine Hand-atlas* in the office of his colleague Emil Take (1879-1925). Wegener was not the first to notice the congruence of Atlantic coastlines, but it led to the first publication of his drift hypothesis in 1912, and more fully in 1915.

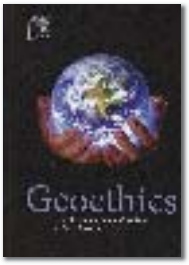
Others have covered different aspects of the enigmatic Wegener's legacy. Henry Frankel has written a comprehensive history of the continental drift controversy; Naomi Oreskes has expertly explored and explained the theory's particular difficulties in the United States. What we have lacked, until now, was a full picture of the man. Now we have it, set masterfully within the wider narrative of historical development in all the subjects upon which Wegener exerted influence (or failed to).

Following the advice of L Pearce Williams, Faraday's biographer, Greene has 'read everything his subject wrote, everything he read, and as much as possible of what the people he read, read'. He has also been everywhere that Wegener went, including Greenland. That labour has taken over 20 years. The result is a magnificent, definitive and indefatigable tribute to an indefatigable man.

Reviewed by ***Ted Nield***

ALFRED WEGENER – SCIENCE, EXPLORATION AND THE THEORY OF CONTINENTAL DRIFT
by Mott T Greene. Johns Hopkins University Press
October 2015 720pp
HardBack Book
ISBN 9781421417127
List price: £29.99

Ethical Challenges and Case Studies in Earth Sciences



This is a book suitable for Earth scientists with an interest in sustainable development and social responsibility. It discusses the ethical issues in the Earth sciences. It includes case studies, showing where experts have gone wrong and where key organisations have ignored facts, wanting assessments favourable to their agendas. It is written by a group of contributors with experience ranging from philosophy to Earth science.

Competition for natural resources increases all the time. Modern societies are increasingly under pressure from shortages in energy carriers, land surface, water, metals, biodiversity etc. Geoethics consists of three main areas: (1) professional ethics of scientists; (2) ethical considerations related to specific projects, and (3) general ethical considerations about the Earth and its components.

Recent developments in the formulation of Research integrity policy are outlined, ending with the 'Singapore Statement'. The four principles and 14 responsibilities of researchers and their institutions are given. One particular problem is plagiarism, which is an offence against decency; not always an illegal action, it is always an ethical problem.

The book refers to the 1980s discussions between the Reagan administration and the Soviets. Reports to the US Congress from the executive branch of government had stated that the Soviet Union was 'in likely violation' of the bilateral Threshold Test Ban Treaty (TTBT) 1974, which imposed a limit of 150 kilotons for the explosive yield of any underground nuclear weapons test conducted by these two countries after March 1976.

Nuclear power plants are a potential risk to the population, when they are located near faults liable to earthquakes and along coasts prone to tsunamis. To maximise profits, estimates of seismic hazard may be minimised, so as to reduce construction costs.

Decision-making under conditions of uncertainty poses serious questions about the decision pathway, its complexities, consequent responsibilities, and, ultimately, the difficulties of identifying the 'correct' decision to make. Analysis of radioactive waste management and the ethical discussion surrounding this topic shows that reflection on side-effects of human actions is, in most cases, neither as clear as should be possible, nor as necessary.

Although geoethics is an important new branch of Earth science, it should be noted that geohazards have been faced since the dawn of civilisation. This is an excellent and thought-provoking textbook and can be recommended most strongly.

Reviewed by ***Steve Rowlatt***

GEOETHICS - ETHICAL CHALLENGES AND CASE STUDIES IN EARTH SCIENCES
Edited by Max Wyss and Silvia Peppoloni Publisher: Elsevier Science Publishing Co Inc
Publication Date: 21 Nov. 2014 425pp
HardBack Book
ISBN 978-0-12-799935-7
List price: £54.89
www.elsevier.com

The Variscan Orogeny

This Geological Society Special Publication presents 14 papers summarising the state of the art in our present understanding of the Variscan Orogeny. In so doing the editors and authors of the volume have had to cover both the northern orogeny, which was characterised by Late-Devonian-Carboniferous rifting, subduction and collision, and the southern orogeny, which was affected by late Carboniferous collision and Permian wrenching. The papers are an excellent mix, helping us develop our understanding and showing how there was a major switch in plate configurations at the Early-Late Carboniferous boundary.

The papers have been arranged to reflect the evolution of the Variscan system in both space and time. In so doing they provide the readership with an insight into not only the similarities, but also the differences between the different orogenic events. These have highlighted the individual tectonic, metamorphic and magmatic events across the European Variscides.

The volume is a valuable addition to the subject as it seeks to explain both major Variscan realms. In the introduction to the volume, the editors state that they hope the volume will contribute to '...the reconciliation of classical European geological wisdom with the plate tectonic paradigm'. This has been achieved, with several new models being presented.

There still remains much to be done on the Variscan Orogeny, but this volume is a superb addition to the subject. I am confident that it will generate further interest and that some of the 'open questions' presented in the conclusions of several of the papers will be suitable goals for future research in the subject.

The quality of the binding is as one has come to expect from the Geological Society, with the papers clearly set out in the double-column format typical of the publisher. There are a number of graphs, maps, sections and charts included with the papers and these have been produced very clearly. It is good to see that the publisher has reproduced many of these in colour as it does help with their interpretation.

The book makes an invaluable contribution to this area of study. With the mixture of papers presented it allows a comparison of several different models and gives a suitable starting point for wider in-depth studies.

I would recommend this book to anyone in the Earth sciences studying in this particular field. I think it should be made available to undergraduates studying the complexities of the development of the European crust and should definitely be found on the bookshelves of all university geoscience departments. The papers herein presented archive our knowledge and opinions on a complex subject at a specific point in time.

Reviewed by ***Gordon Neighbour***

THE VARISCAN OROGENY - EXTENT, TIMESCALE AND THE FORMATION OF THE EUROPEAN CRUST
Edited by: K Schulmann, J R Martinez Catalán, J M Lardeaux, V Janoušek and G Oggiano
ISBN: 978–1–86239–658-6
Geological Society Special Publication 405
List price: £120.00
Fellows price: £60.00
www.geolsoc.org.uk/bookshop

Quarrying industry in Wales - a history

The first impression is of a weighty, colourful A4 publication but the greatest pleasure, in addition to the low price of just shy of £20, is the content. Despite the title ("a history") this is a series of vignettes concerning quarries and their geological setting across the country. Fascinating stuff, and easy to dip into as the mood takes the reader.

The scene is set with a concise overview of the history of stone usage and extraction in Wales, taking the reader through to the planning and economic constraints faced by modern industry.

Arranged by general geographical area from north to south, the reader is taken on a journey through the quarrying industry with the principal focus on the last two centuries. The small geological maps introducing each chapter add a touch of colour as well as providing location markers; but it took me a while to realise that there was also a fold-out key, printed on the cover, enabling me to interpret the various colours as well as act as a page-marker!

The author has so much to share and has cleverly incorporated many extra insights using box inserts, for example 'Limestone: the world's most useful rock' which reveals the huge number of products for which this stone is used. Others range from types of buildings (e.g. the medieval Stanley churches), through people and organisations (e.g. the Institute of Quarrying), to a number of beautiful mineral specimens that have been discovered (e.g. azurite and xanthoconite, a rare silver/arsenic/sulphur mineral, from Dolyhir). Appropriate for the intended general readership, references are to background reading rather than rigorous listings of all relevant publications.

Mining is not addressed. There is only passing mention of underground workings for lime, slate and sand, plus one large photograph: of the Dinas Silica Mine, producer of furnace bricks. The book ends with appendices pointing readers to sources of additional information, from the Welsh Stone Forum, through ideas for educational course development, to explanations of acronyms and a glossary.

The author is planning a similar volume on Quarrying in Derbyshire and the Peak District, and we can but hope that he will go on to write companion volumes on the quarrying industries elsewhere in England, Scotland and Ireland!

Reviewed by ***Mike Rosenbaum***

QUARRYING INDUSTRY IN WALES: A HISTORY / Y DIWYDIANT CHWARELI YNG NGHYMRU - HANES
by Ian A Thomas, 2015. Published by: National Stone Centre 224 pp (pbk)
ISBN: 978 1 871 82738 5
List price: £19.95

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! Microbial Carbonates in Space & Time - implications for global exploration and production. 2015** By D. Bosence et al. GSL Special Publication #418 308pp, hbk.
- **NEW! Applied Thermodynamics for Meteorologists,** by Sam Miller. 2015. Cambridge University Press 285pp, hbk.

PEOPLE *NEWS*

CAROUSEL

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

◆ Ed Jarzembowski

Has received a Friendship Award from the Jiangsu Province of China, presented by the Provincial People's Government in September. Ed has been Visiting Professor at the Nanjing Institute of Geology and Palaeontology, Chinese Academy of Sciences, since 2012, where his research into fossil insects has led to the publication of many papers with colleagues at the Institute. He has studied and undertaken fieldwork on mainly British fossil insects since the 1970s, and his work at Nanjing has allowed him to explore the links between the English Wealden and exceptionally preserved, Lower Cretaceous Chinese fossil insect faunas.

◆ Geoff Warrington

A Senior Fellow and CGeol., Honorary Visiting Fellow in the Geology Department at Leicester University, is completing a revision (begun by the late Denys Smith) of the Society's Special Report No.5, *A Correlation of Permian Rocks in the British Isles*. Revision of Special Report No.13, *A Correlation of Triassic rocks in the British Isles,* will follow.

'A pretty crinoid. Just for the hell of it

Image: Michal Ninger/Shutterstock.com

IN MEMORIAM WWW.GEOLSOC.ORG.UK/OBITUARIES

THE SOCIETY NOTES WITH SADNESS THE PASSING OF:

Barker, R W N *
Golden, Michael *
Grinly, David *
Haddow, Douglas *
McNicholas, J B *
Weston, Leigh

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**.

Fossil help needed!

Maybe you can help sort out some fishy fossils for a local museum?…

John Heathcote sets off in search of fossilists

John Heathcote writes: Caithness Horizons, my local museum, has a collection of geological specimens. They range from what appear to be some very miscellaneous lumps of rock, to some fine fossil fish (presumably Devonian) and plants (Mesozoic?). The collection includes specimens from Robert Dick and may include some important material. The curator of the museum has been in touch with a number of us geologists working at Dounreay for help in sorting the wheat from the chaff.

While we are happy that we can make substantial progress with basic sorting of the collection into categories, such as worthy of display, useful material for schools teaching etc., none of us has more than very basic palaeontological expertise.

➤ We would welcome contact from anyone who could assist, on a voluntary basis, with the fossils. Contact **E: j_a_heathcote@ hotmail.co.uk**

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

DISTANT THUNDER *Home away from home*

*Geologist and science writer **Nina Morgan*** reflects on war memorials to the ANZAC fallen*

As popularity of the *Love and Sorrow* exhibition, now running at the Melbourne Museum in Australia highlights, war graves and monuments to ANZAC soldiers killed during the First World War still hold great meaning in Australia. The fact that along with the death of their sons, brothers and husbands, many Australian families suffered the further loss of never being able to afford to visit the grave of their fallen – or even to know the comfort of being able to include an epitaph on the gravestone – only adds to their poignancy.

In Australia, families of the fallen who wanted to add an epitaph to the standard war grave were charged threepence ha'penny for every letter and every space. This was an expense that many could not afford, and vigilant officials pursued families into the 1920s for failure to pay. The War Graves Commission also exercised a form of censorship and reserved the right to veto any epitaph it deemed inappropriate. Many grieving mothers, fathers and wives were told that their last message was too long, cumbersome, inartistic or even too sentimental.

Prosperous

Now that people are more prosperous and travel is easier, regular tours are organised to the cemeteries and memorials to the ANZAC fallen in Gallipoli. The tower of Australia's National Memorial, erected at Villers-Bretonneux in France in memory of the more than 800 Australians killed on the Somme during the First World War is a also place of pilgrimage for many. Although this handsome structure, designed by Edwin Lutyens and made of what appears to be Portland stone, shines out bright white on the horizon – it was never meant to be like that.

The original plans stipulated that this monument should be built entirely of Australian stone. The idea was to freight stone thousands of miles across the oceans to plant a piece of Australia in France, in effect to bring a piece of home to the Australian soldiers who – because of the decision not to repatriate ANZAC dead – would never see their homeland again. But the Great Depression after the war intervened. Funds ran out, and the plan for a uniquely Australian memorial was never actually realised.

Hyde Park Corner

But many years later, this dream was granted – to a degree. The Australian War Memorial in Hyde Park Corner London, designed by the Australian architectural firm Tonkin Zulaikha Greer and the Sydney-based Australian artist Janet Laurence, which was completed in 2003, commemorates the efforts of the Australian Servicemen, allied with those of Great Britain, in both World Wars. It is clad in a 2.6Ga green granite from the Yilgarn Craton near Jarramungup in SW Australia. Cut in Australia and shipped to London, the stone – known in the trade as Verde Laguna – is composed of blue-green microcline feldspar, hornblende, plagioclase and quartz.

Acknowledgement
Information about the stone used in other Australian war memorials has proved hard to find. Perhaps readers can help? This vignette was inspired by the Monash University online MOOC course, *World War I: A history in 100 stories* available on **www.futurelearn.com**. Other sources include an article by Ruth Siddall, *The Stones of London's War Memorials: Urban Geology in London No. 23*, published in 2014 and available from: **www.ucle.ac.uk/~ucfbrxs/Homepage/walks/WarMemorials.pdf,** and information about the Australian War Memorial at **www.tzg. com.au/project/aus-war-memorial/** and Wikipedia

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

Australian War Memorial

OBITUARY ROBIN NICHOLSON 1932-2015

Field geologist who made lasting contributions to the geology of the Scandinavian Caledonides

Robin Nicholson was the complete field geologist. In his field-based research he combined deep knowledge and scientific rigour with energy, physical endurance and persistence. He will be remembered particularly for his major and lasting contributions to our understanding of the geology of the Scandinavian Caledonides. He also carried out significant research elsewhere in Europe and in East Africa.

Robin was brought up in Berwick-upon-Tweed. In 1950 he gained a place at Hull University to read geography, which he did not enjoy and so left to do his National Service. In the RAF he revelled in the challenges of flying, training with the RCAF in Gimli, Manitoba.

Norway

On his return to civilian life he applied to read geology at University College, London in the small department led by Professor S E Hollingworth. He graduated in 1956, winning the Sir Henry Mier's prize. He and Brian Walton then joined Professor Hollingworth's research group in Nordland, Norway, extending the work of Roye Rutland and Keith Ackerman to the critical Glomfjord area (immediately NE of the Svartisen permanent ice cap). His PhD was a landmark study of an area which at that time was accessible only on foot. Fieldwork was demanding in difficult mountainous terrain with variable weather, deepening his respect for the pioneers of Nordland geology.

In 1957 Robin was appointed assistant lecturer at Bedford College where he completed his PhD. Here he met Judy whom he married in 1961. In 1960 Robin moved to Professor Deer's department at Manchester University. He and his own PhD students maintained the connection with the UCL group, and he effectively became the leader of the expanding UK effort in Nordland from the mid-1960s. Robin helped to found the Tectonic Studies Group (TSG) of the Geological Society in 1970, and was an early member of the History of Geology Group (HOGG). He was also an active participant in the Geologists' Association.

In the 1970s, Robin's research extended eastwards into Sweden, in order to tackle the wider problems of nappe relationships. Links with Sweden were strengthened through Mike Wilson, his graduate student, sadly killed in Nicaragua. Robin's research not only applied the developing techniques of structural geology in the field but also modern geochemical and geochronological techniques to the elucidation of tectonic relationships. These resulted in important reviews of Caledonian geology, in 1974 and 1979.

Small-scale structures

In spite of accelerating health problems and decreasing mobility which brought his Norwegian research to an untimely end, Robin persisted with less demanding fieldwork, focusing on the mechanics of small-scale structures. The formation and propagation of veins and dykes remained a passionate interest until the end of his life.

Robin officially retired in 1994, and in 1999 he and Judy moved to Berwick-upon-Tweed where he greatly enjoyed visits from his three granddaughters and many former colleagues and friends. He died from pneumonia on 30 March 2015 and is survived by Judy, his wife of 54 years, son Hugh and daughter Sally.

By **H & J A Nicholson, R Rutland, S & J Treagus**

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, publications list and a photograph to Ted Nield at the Society.

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DIARY OF MEETINGS EVENTS 2015

COURSE	DATE	VENUE AND DETAILS
Celebrating the Genius of William 'Strata' Smith GSA, William Smith Bicentenary	1 November	Conference, Field excursion. **Venue:** Baltimore, Maryland, USA. Part of the GSA Annual Meeting. See website for registration and details.
Field excursion to Upware, Cambs. GA	November tba	**Venue:** Upware. **Leader:** Dr Simon Kelly. Precise details not available. See website for updated information.
Future Mining 2015 AusIMM	4 November	**Venue:** Australia Technology park, Sydney. See website for registration and details. **W:** www.futuremining2015.ausimm.com.au/. **E:** Cassandra Benn conference@ausimm.com.au.
19th Glossop Award Engineering Group	4 November	**Venue:** Burlington House. See website for details and registration. Fees and discounts apply. **E:** engineering.group@geolsoc.org.uk
Conference and Exhibition 2015 Museums Assoc.	5-6 November	**Venue:** Birmingham International Convention Centre, Birmingham. **Contact:** Emma Mitchinson **E:** emma@museumassociation.org. **W:** www.museumsassociation.org
William Smith Meeting 2015 (Part 2) - 200 Years and Beyond: The Future of Geological Mapping GSL, William Smith Bicentenary	5 November	**Venue:** Burlington House. See website for details and registration. Fees and discounts apply. **Convener:** Andy Howard (BGS). **Contact:** Laura Griffiths **E:** laura.griffiths@geolsoc.org.uk
An insight into the resource, techniques and methods available for cost-effective reservoir description - at BGS Open Day Petroleum Group	11 November	Workshop. **Venue:** BGS, Keyworth. See website for details and registration. Fees and discounts apply. **Contact:** Laura Griffiths **E:** laura.griffiths@geolsoc.org.uk
BS80881 (2105) Code of practice for grouted anchors North West regional	11 November	Lecture. **Venue:** Jacobs, 5 First Street, Manchester. **Speaker:** Dr Caesar Merrifield. Convener – Nik Reynolds. **E:** geologicalsociety.northwest@gmail.com.
Puzzle of Earth's Uninterrupted Habitability GSL, Year of Mud	11 November	Conference. **Venue:** Burlington House. See website for details and registration. Fees and discounts apply. **Conveners:** Dave Waltham, Graham Shields. **Contact:** Laura Griffiths **E:** laura.griffiths@geolsoc.org.uk
Explore 2015: the expedition and fieldwork planning weekend RGS	13-15 November	Conference. RGS, Kensington Gore. See website for details and registration. Fees and discounts apply. **E:** go@rgs.org. **W:** www.rgs.org/explore.
Geomechanical and Petrophysical Properties of Mudrocks GSL, Year of Mud	16-17 November	Conference. **Venue:** Burlington House. See website for details and registration. Fees and discounts apply. Convener; Ernie Rutter et al. **Contact:** Laura Griffiths **E:** laura.griffiths@geolsoc.org.uk
Landscape Dynamics, Erosion and Sedimentation GSL	18 November	Conference. Venue: Burlington House. See website for details and registration. Fees and discounts apply. **Contact:** Annie Sewell **E:** annie.sewell@geolsoc.org.uk
Nottingham Careers Day 2015 GSL	18 November	Fair, Workshops. **Venue:** BGS, Keyworth. See website for details and registration. Fees and discounts apply. **Contact:** Laura Griffiths **E:** laura.griffiths@geolsoc.org.uk
Virtual Palaeontology Home Counties North RG	19 November	**Venue:** Sir Robert McAlpine, Hemel H. **Time:** 1800 for 1830. Free. Speaker; Mark Sutton, Imperial College **E:** homecountiesnorthregionalgroup@gmail.com
Edinburgh Careers Day 2015 GSL	25 November	**Venue:** Our Dynamic Earth, Edinburgh. See website for details and registration. Fees and discounts apply. **Contact:** Laura Griffiths **E:** laura.griffiths@geolsoc.org.uk
Early Career Geologist Award Final Southern Wales RG	25 November	**Venue:** LT1.40, School of Earth and Ocean Sciences, Cardiff University. Time not published at time of writing. See Website. **Contact: E:** swales.rg@geolsoc.org.uk. **W:** www.geolsoc.org.uk/south_wales
Geomechanics of Shale and the production of shale gas North West RG	26 November	**Venue:** Manchester University. **Time:** 18.30. **Speaker:** Dr Julian Meckleburgh (Manchester Uni). Convener: Nik Reynolds. **E:** geologicalsociety.northwest@gmail.com

OBITUARY JULIA HUBBARD 1940-2015

Carbonate sedimentologist who championed the role of 'bugs' in the sedimentary record

In March of this year, Julia Hubbard died, almost 40 years after I first met her in the bowels of King's College, London. In 1976 I was visiting my supervisor at Sheffield, when the phone rang. It was Julia enquiring if there were any students who wanted to do a PhD working on coral reefs in Australia. "Here, talk to Julia Hubbard" he said: "She has a NERC funded PhD position and is looking for someone who is handy and can scuba-dive".

Australia

Having accepted the position I was soon on my way to Australia where, for three months Julia and I explored the reefs. I returned to London and with introductions from Julia started to implement the one-paragraph project. Three years later with the PhD completed I realised that Julia had been way ahead of her time. She not only joined Robin Bathurst and Robert Ginsburg as a pioneer of modern comparative sedimentology, but she championed the importance of 'bugs' in altering the sedimentary record. She had an infectious enthusiasm.

> "SHE HAD AN INFECTIOUS ENTHUSIASM"

Julia was born in 1940, the daughter of an architect who was involved in the post-war reconstruction of the Middle East. As a consequence, a great deal of her childhood was spent in this region. According to her brother she developed a late interest in geology and after taking additional courses, and was accepted to Bedford College, London.

Graduate work on the Carboniferous reefs around Sligo, NW Ireland followed. In 1966 she accepted a lecturer position at King's College. At that time she could really be described as a pioneer in the field, being one of only two women geologists at the University of London.

At King's her research shifted from ancient to modern, working on reefs in Australia, Africa and the Caribbean. In addition to myself, she mentored several other graduate students, some with unexpected career results. Alistair Crame, currently at the British Antarctic Survey, was joint student with the Natural History Museum and worked on the Pleistocene reefs of the Kenyan coast. Derek Kinchington completed his PhD on the calcification of modern cold-water corals using biological techniques that he subsequently employed in viral research. Her final student, who was working on microbial mechanisms of calcification, never completed her dissertation.

Rationalisation

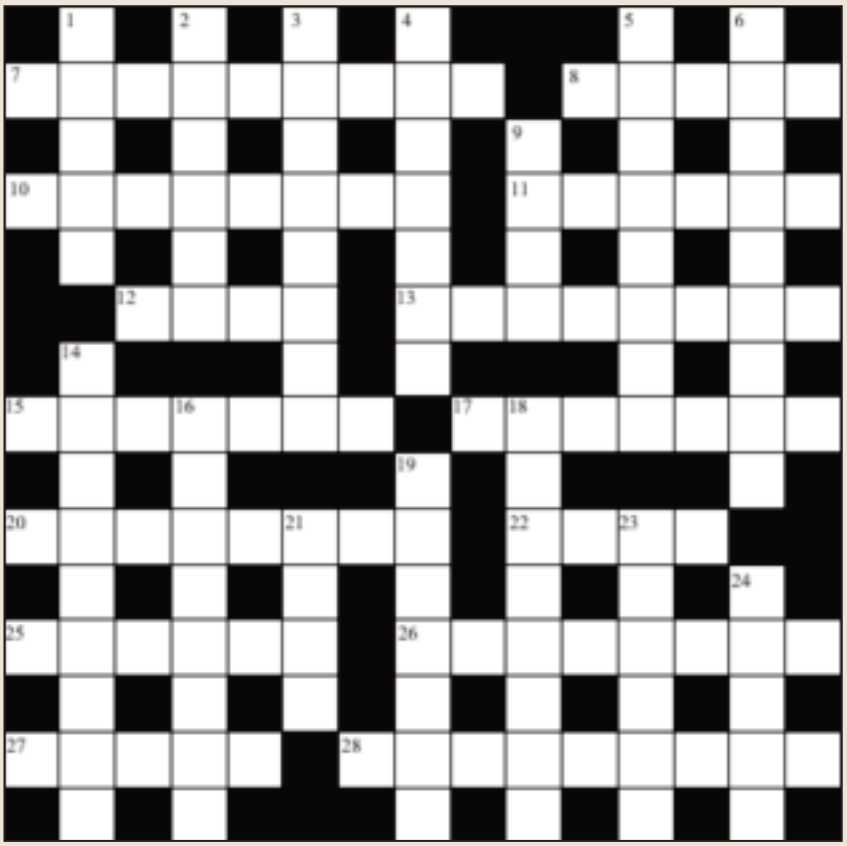
As a result of the unfortunate UGC 'rationalisation' of university geology departments in the UK, the Department at King's College was amalgamated with several others in London and relocated to Royal Holloway. Julia Hubbard, along with her colleague Jake Hancock, refused to move. Julia received only limited support for her work after this - although she continued to attend meetings related to coral reefs, both locally and internationally.

Many acquaintances will have different recollections of Julia. Some remember her as someone who was difficult to understand, others remember an intellect way ahead of her time. I remember a kind and caring individual who was a combination of both of these, and someone whose academic record underestimates her contribution towards modern comparative sedimentology.

By **Peter Swart**

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, publications list and a photograph to Ted Nield at the Society.

CROSSWORD NO.197 SET BY PLATYPUS



ACROSS

7 Holocrystalline, intrusive igneous rock composed of interlocking phaneritic crystals usually larger than 2.5 cm (9)

8 Dwelling place (5)

10 Loose, heterogeneous superficial material covering solid rock (8)

11 Distinct juvenile animal forms, before metamorphosis (6)

12 Sparkling vino from Piedmont (4)

13 North American Silurian stage roughly 438 to 421.3Ma (8)

15 Windy city, where a river changed direction (7)

17 UK oil company formed out of BNOC in 1982 (7)

20 Carbonaceous chemical formed by the distillation of various tars and used in preservation and medicine (8)

22 At right angles to strikes (4)

25 Sudden muscular contractions (6)

26 Unit of measurement for the exposure of X-rays and gamma rays up to several MeV (8)

27 Horizontal or semi-horizontal mine shafts (5)

28 Constituent mineral, present in small quantity but not taken into account in identifying a rock (9)

DOWN

1 Quantitative flow-counting measuring device. (5)

2 To mould, or carve in relief (6)

3 Helvellyn has the Edge (8)

4 The art of using strong acid or mordant to cut into the unprotected parts of a metal surface to create a design (7)

5 Departing from the accepted norm: heteromorph ammonites, for example (8)

6 Occurring without gain or loss of heat (9)

9 Photosynthetic organism of aquatic or moist habitats, from single-celled to large seaweed (4)

14 Bipedal saurischian dinosaurs (9)

16 Inosilicate double chain sodic amphibole belonging to the riebeckite group (obs.) (8)

18 Moved towards the longer wavelength end of the spectrum: space-weathered asteroids, for example (8)

19 Solid geology, under the 10a (7)

21 traditional agricultural kiln building for the drying of hops (4)

23 Any of various mined and manufactured salts containing water-soluble potassium (6)

24 US Rear Admiral with his name on N Greenland (5)

WIN A SPECIAL PUBLICATION!

The winner of the September Crossword puzzle prize draw was Roy Harris of Doncaster.

All correct solutions will be placed in the draw, and the winner's name printed in the February 2016 issue. The Editor's decision is final and no correspondence will be entered into. **Closing date – December 4**.

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

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

Name .....

.....

Membership number .....

Address for correspondence .....

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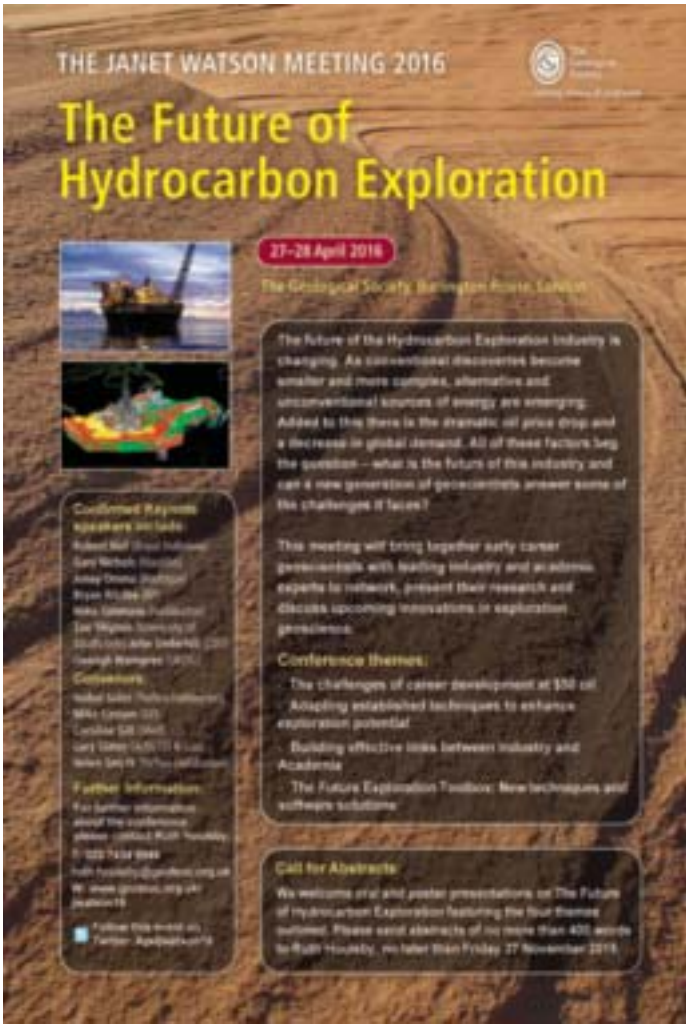
Postcode .....

SOLUTIONS SEPTEMBER

ACROSS:
1 Permafrost **6** Atop **9** Analytical **10** Lair
12 Emasculation **15** Flintlock **17** Atoll
18 Ennui **19** Enslaving **20** Intransigent
24 Airs **25** Downstream **26** Easy **27** Ostracised

DOWN:
1 Peal **2** Ream **3** Asymmetrical **4** Reims
5 Seaquakes **7** Tragicomic **8** Phrenology
11 Paramagnetic **13** Effeminate **14** Signatures
16 Overshoes **21** Goner **22** Zeus **23** Amid


THE JANET WATSON MEETING 2016
The Future of Hydrocarbon Exploration
27–28 April 2016
The Geological Society, Burlington House, London
The future of the Hydrocarbon Exploration industry is changing. As conventional discoveries become smaller and more complex, alternative and unconventional sources of energy are emerging. Added to this there is the dramatic oil price drop and a decrease in global demand. All of these factors beg the question – what is the future of this industry and can a new generation of geoscientists answer some of the challenges it faces?
This meeting will bring together early career geoscientists with leading industry and academic experts to network, present their research and discuss upcoming innovations in exploration geoscience.
Conference themes:
- The challenges of career development at $50 oil
- Adapting established techniques to enhance exploration potential
- Building effective links between industry and Academia
- The Future Exploration Toolbox: New techniques and software solutions
Call for Abstracts:
We welcome oral and poster presentations on The Future of Hydrocarbon Exploration featuring the four themes outlined. Please send abstracts of no more than 400 words to Ruth Housley, no later than Friday 27 November 2015.


The Geological Society
Registration Now Open
European Oil & Gas Industry History conference
3-4 March 2016
Burlington House, Piccadilly, London
This joint conference between the Petroleum Group of the Geological Society, the History of Geology Group of the Geological Society and the Petroleum History Institute will be held in London in March 2016. It will mark several important anniversaries including 150 years of oil exploration in Poland & Romania, the centenary of the drilling of the first oil well in the UK, and 50 years of oil production onshore Spain. The focus of the conference will be to examine the history and heritage of the oil and gas industry in Europe from the earliest onshore drilling (and digging) to its development into the industry that we know today and also to examine the transition from conventional to unconventional resource plays in the onshore arena.
Associated Events:
A fieldtrip will be arranged over the weekend following the conference to examine the history, industrial archaeology and geology of the UK's earliest oil and gas fields in the east Midlands and the Peak District. During the trip a memorial plaque and information board will be unveiled at the Hardstoft-1 well site in Derbyshire, marking the 100th Anniversary of the drilling of the well under the defense of the Realm Act to reduce Britain's dependence on oil imports.
Registration:
To register for the conference please visit the webpage
www.geolsoc.org.uk/PG-European-Oil-and-Gas-Industry-History-Conference
For further information please contact:
Laura Griffiths: The Geological Society, Burlington House, Piccadilly, London W1J 0BG. T: 020 7432 0980 or email: laura.griffiths@geolsoc.org.uk
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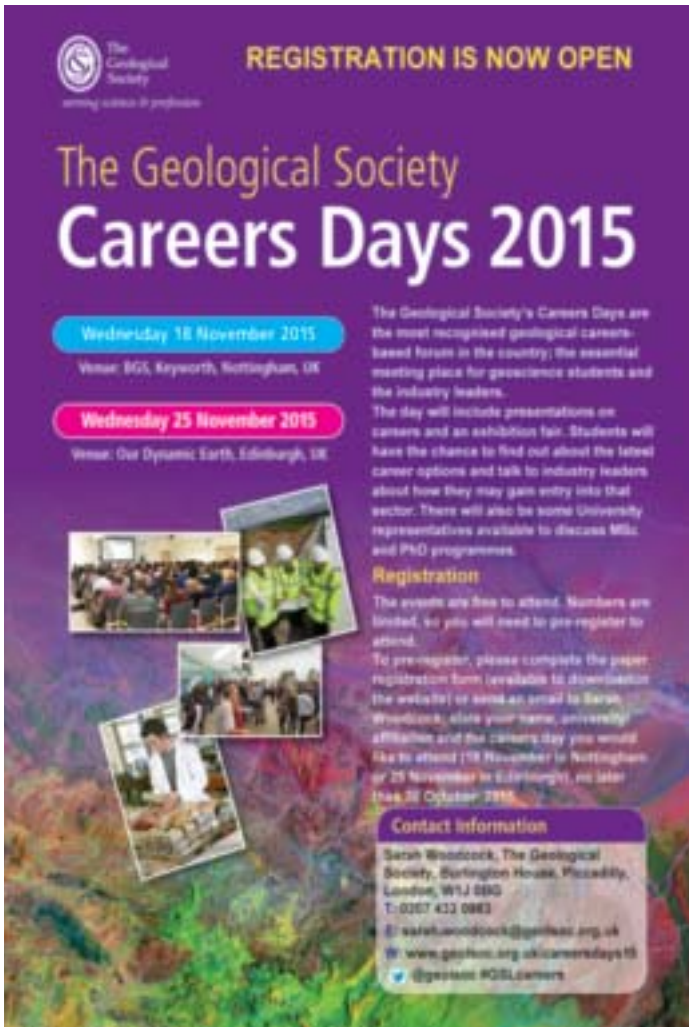
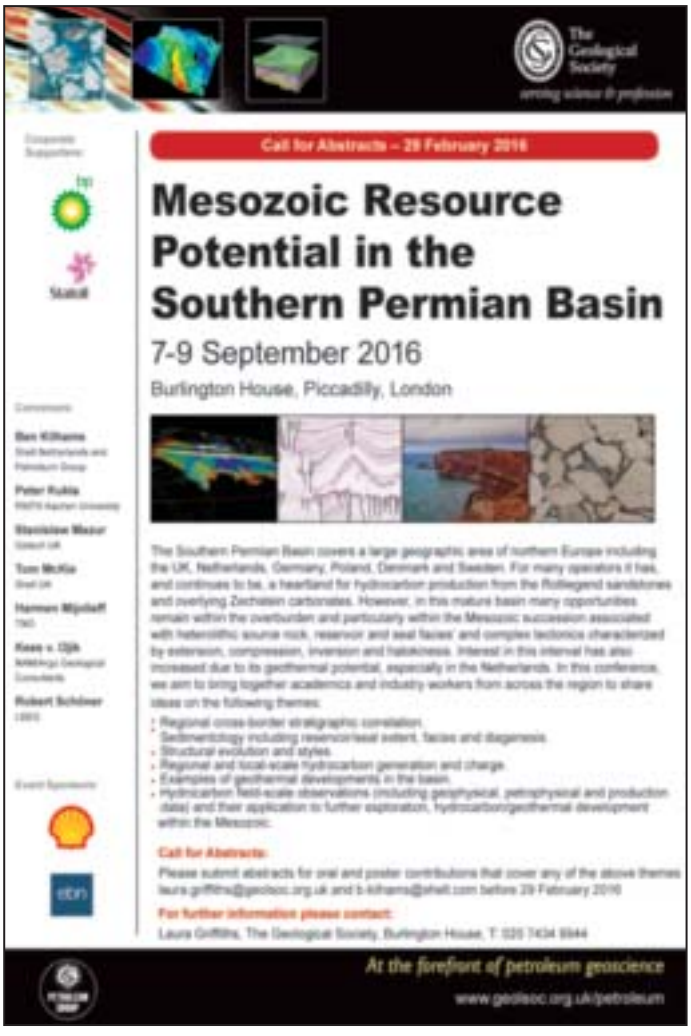

The Geological Society
REGISTRATION IS NOW OPEN
The Geological Society
Careers Days 2015
Wednesday 18 November 2015
Venue: BGS, Keyworth, Nottingham, UK
Wednesday 25 November 2015
Venue: Our Dynamic Earth, Edinburgh, UK
The Geological Society's Careers Days are the most recognised geological careers-based forum in the country; the essential meeting place for geoscience students and the industry leaders.
The day will include presentations on careers and an exhibition fair. Students will have the chance to find out about the latest career options and talk to industry leaders about how they may gain entry into that sector. There will also be some University representatives available to discuss MSc and PhD programmes.
Registration
The events are free to attend. Numbers are limited, so you will need to pre-register to attend.
To pre-register, please complete the paper registration form (available to download from the website) or send an email to Sarah Woodcock, state your name, university affiliation and the careers day you would like to attend (18 November in Nottingham or 25 November in Edinburgh), no later than 30 October 2015.
Contact Information
Sarah Woodcock, The Geological Society, Burlington House, Piccadilly, London, W1J 0BG
T: 0207 432 0883
E: sarah.woodcock@geolsoc.org.uk
W: www.geolsoc.org.uk/careersdays15
@geosoc #GSLcareers


The Geological Society
Call for Abstracts – 29 February 2016
Mesozoic Resource Potential in the Southern Permian Basin
7-9 September 2016
Burlington House, Piccadilly, London
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
Call for Abstracts:
Please submit abstracts for oral and poster contributions that cover any of the above themes 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, T: 020 7434 9944
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www.geolsoc.org.uk/petroleum

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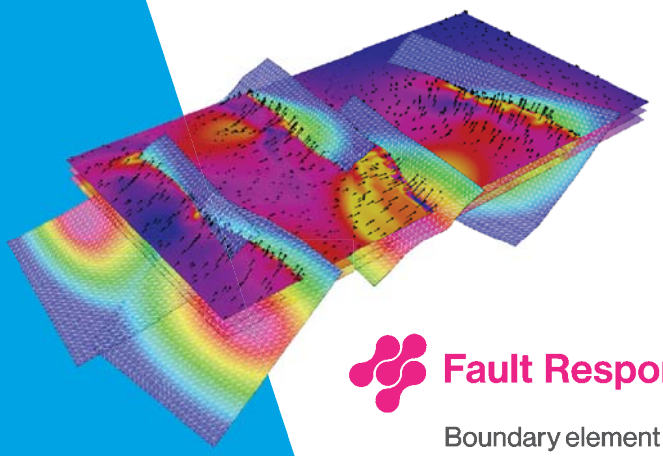
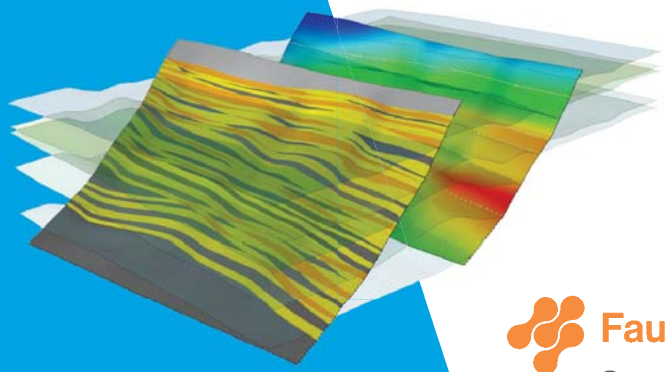


Fault Response Modelling

Boundary element modelling to simulate displacement on faults, and geomechanical analysis of surrounding fracture systems



Fault Analysis

Quantitative analysis of fault throw, juxtaposition and seal through geological time

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