The Fellowship magazine of THE GEOLOGICAL SOCIETY OF LONDON

Geoscientist

Volume 20 · No 11 · November 2010

- Libyan fieldwork
- Climate change statement
- Advising Mike Leigh

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Sturdy ostensibles

To understand the imperatives of organisations, it is useful to turn idealism on its head once in a while, says Ted Nield

As the man said, when hauled up before Brighton magistrates for punching a palm-reader who smiled while delivering bad news; one always strives to strike a happy medium – as organisations no less than as individuals. At one end of a slippery pole, Gradgrind businesses run entirely for the owner and customer's benefit, work to the detriment of employees and their rights. At the other, faceless entities responsible to nobody but themselves follow internal rules for their own convenience, to the exclusion of outsiders in a totalitarian Kafkaesque nightmare.

But these are extremes. In reality, services of any kind should involve a partnership between provider and receiver, from which each derives appropriate and proportional satisfaction. Schools exist to teach children, but they also exist to employ people who want to be teachers. Hospitals exist partly because many people have a burning vocation to be doctors and nurses. Universities teach students, but exist at least in part for the same reason that monasteries used to – because many clever people yearn to be left alone with their books and be protected. Once, such folk obtained everyone's consent by taking their tithe for serving a God whom everyone feared. Today's universities like everyone else turn to Mammon, and tell everyone of the huge economic benefit they bring, in return for a trifling investment in research and teaching.

Universities sell aspiration, and their commercial imperative means finding and filling holes in the market with new qualifications that promise to achieve them. Twenty years ago science journalism had no formally established career path. Now there are courses - which, merely by existing, have become the essential entry-level benchmark. This brings many benefits. A cynic might say the universities have played their usual confidence trick, and so helped to make our society even more neotenous than it already is. And true, those entering the profession now come to it a year or two later, further in debt, lower on the property and pension ladder, and still have much to learn on the job. But on the whole, universities are doing very nicely, while students and recruiters now have a front door to aim at.

In this, the month of our Founders' Dinner, we recall that this Society's forefathers aspired to make geologists acquainted with one another, stimulate their zeal, adopt one nomenclature, communicate new facts and ascertain what remained to be discovered. And we still perform all these core activities through publishing, conferences, and (of course) eating, drinking and kicking our legs up a bit.

But today the partnership extends further. We also tap into Fellows' desire to do more together than one can achieve alone. No-one can save a whale unaided – but if that's what floats your boat, you can join *Greenpeace* who'll do it for you. Geologists want to make their voices heard – but 10,000 voices sound more loudly than one. These are all our sturdy ostensibles, worthy objects in their own right. Yet from the "membership organisation" point of view (and as *Greenpeace* amply demonstrates with its excellent PR) why save the damned whale if your paying supporters never find out you did it?

- Thus, in this issue of *Geoscientist*, see how the Society advises Government (pp10,24), the public at large (p21) and film makers (p7). Find out how you can get involved (p21).

Front cover: Sandfield at the western margin of the Kufra Basin, Libya. See Feature, p16.

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For your own good

After "fire!" and "poetry", few words have quite the power to clear a public space quickly as "health & safety". But we ignore it all at our peril, says John Anderson

In a career spanning 40 years I have learned that there is nothing quite like health and safety (H&S) at work to cause my colleagues' eyes to cross with boredom. But no-one actually wants to be injured, any more than they can, in reality, escape their duty to observe H&S legislation. Nor should they try. Legal health and safety duties apply to *all persons at work*, whether employed or self-employed. And the term "persons at work" means not only all individuals, but also all corporate bodies and partnerships.

Dangers lurk all around us, even in ordinary situations like crossing the road; but the world of work brings with it a range of hazards and risks that may not be seen or heard or easily detected - but which can all too easily result in severe accidents and long-term disability. Chemicals, dusts, fumes, fibres, noise, vibration, confined spaces (not to mention physical hazards like trips, falling objects, collapsing structures and excavations etc.) - the list is almost endless. But where can one start to get any sort of 'handle' on ensuring your own health and safety?

The fount of all knowledge and understanding on H&S issues must surely lie in the original law and regulations in which they are enshrined. Their purpose is to alert those who have a duty of care to what it is they should do. It tells them precisely how to go about implementing methods of prevention and risk control. So what are they?

The first and foremost law in the H&S canon is the *Health and Safety at Work Act 1974,* which lays duties upon employers, employees, self-employed persons and on senior managers and directors. The next most important is the *Management of Health and Safety at Work Regulations 1999,* which carries within it the dread words "risk assessment". Nevertheless, it contains lots of other material as well.

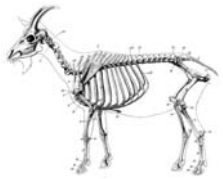
Following on, we come to the *Construction (Design and Management) Regulations 2007*, which actually define 'construction work' (very wide); 'contractors'; 'competence' (and we are talking technical *and* health & safety competence) and 'design'. What *you* think these terms mean is of no account – what really matters is what the law itself says. The definition of 'construction work' includes, for example, site clearance, site exploration, and site investigation and excavation. The definition of 'design' includes drawings, calculations, design details, specifications and bills of quantities. Do you use 'work equipment' ? Then you will also have to add to this litany of relevant legislation the *Provision and Use of Work Equipment Regulations 1998.*

There is no way anyone can or should seek to avoid (and certainly not to evade!) any of this important law. "Doing things right from the beginning" is the appropriate reaction. What is more, doing so will bring the added benefit that it might serve to keep you clear of another important and relevant piece of legislation.

The *Corporate Manslaughter Act 2007*.

Dr John Anderson *CEng, FICE, FGS is an independent consulting civil engineer and expert witness in occupational health and safety in construction. See* www.safeconstruction.net.

Does something in your geological life really get your goat? If you can rant entertainingly about it in 500 words, share your frustration in *Soapbox*. Email your piece, and a separate mugshot, to the Editor at **ted.nield@geolsoc.org.uk.**



Contents

In next month's issue

- CPD monitoring changes
- Geoengineering
- Weymouth's relief

Carousel

Martin Culshaw has received the Hans Cloos Medal, the senior award of the International Association of Engineering Geology and the Environment (IAEG), presented to an engineering geologist of outstanding merit in commemoration of the "founder of geomechanics". The recipient is a person of international repute who has made a major contribution to engineering geology in written papers or to the development of engineering geology and/or the IAEG in their own area. The presentation took place at the IAEG Conference in New Zealand in September.

Chris Jack has recently joined GeoRisk Solutions (GRS) as a Senior Engineering Geologist. GRS are a Hong Kong based engineering geology consultancy specialising in landslide hazard and risk assessments. In addition GRS undertake high quality, project-specific engineering geological mapping and investigations as well as the rapid development of geological, ground and design models for a wide variety of civil engineering applications. In his new role Chris will be involved in business development, expanding the company's rock engineering and tunnel assessment capabilities.
E: cjack@georisksolutions.com T: (852) 2542 3898.

Jane Whaley, a geologist and writer with over 30 years' experience in the oil industry, has been appointed Editor in Chief of *GeoExPro*. Jane was previously Head of Technical Studies for IHS Energy in the UK and spent several years working for the Marine Institute in Dublin. She started her career as a geologist with Decca Survey in 1977, when she led a breakthrough in the industry by becoming the first woman to be employed offshore by the company, and one of the first ever working in the North Sea.
E: jane.whaley@geoexpro.com.

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

Personals

French unseen

Cherry Lewis writes: The History of Geology Group (HOGG) is looking for someone to translate the De Bournon letters in the Ferguson archive (about which more in a future issue). Comte de Bournon wrote in (18th Century) French, while Ferguson replied in English. We can't pay, I'm afraid, but if anyone is interested in translating these fascinating letters for the love of it, I would be very interested to hear from them. E: Cherry.Lewis@bristol.ac.uk

Deaths

• Read obituaries online at www.geolsoc.org.uk/obituaries.

The Society notes with sadness the passing of:

Davies, Rhys*
Harwood, H J*
Locke, Matthew*
Mann, Paul Dunstan*
Morley, William*
Murphy, Richard (Dick)
Pearson, Christopher Martin*

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

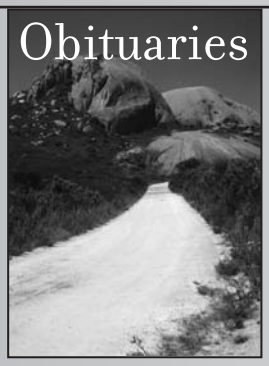
If you would like to contribute an obituary, please email ted.nield@geolsoc.org.uk to be commissioned. You will receive a deadline for submission. You can read the guidance for authors at www.geolsoc.org.uk/obituaries. To save yourself unnecessary work, please do not write anything until you have received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

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

Help your obituarist

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

Obituaries



Obituaries appear in *Geoscientist* as soon as possible after they are published at www.geolsoc.org.uk/obituaries, where you will also find instructions to authors. If you wish to write an obituary for any of the deceased marked with an asterisk in the *Deaths* column, please contact Ted Nield to be commissioned. All communication should be addressed to ted.nield@geolsoc.org.uk. Please do not write anything until you have been commissioned.

Harry Blackmore Whittington 1916-2010

Harry Whittington, Cambridge Professor, Wollaston medalist (2001) and until his death at age 94, the world's leading authority on trilobites, led a brilliant and influential scientific team that brought the Burgess Shale fossils (Middle Cambrian, British Columbia, Canada) to scientific prominence and international attention. Whittington and his students, including luminaries such as Derek Briggs and Simon Conway Morris, pioneered advances in our understanding of the taphonomy, systematics and evolutionary significance of these now famous Cambrian fossils.

Leading his team via several methodological guideposts, Whittington showed the path that led the group to an unprecedented series of major discoveries. Whittington's first guidepost is his own detailed, painstaking descriptive work. His discussion (p. 84, *Treatise on Invertebrate Paleontology, Part O revised, Trilobita*) of supposed colour markings in trilobites is a case in point. Here the focus is on parsing the geochemistry behind the enigmatic shell patterns. A race to interpret the paleoecological significance of the supposed colour markings (important as this may be for future investigation) is notably absent from the discussion.

Whittington's second guidepost reads: "Follow the evidence wherever it leads." In a magic moment in the history of science, laughter from the professional audience greeted Whittington's 1972 restoration of the goggle-eyed, proboscis bearing *Opabinia*. The levity left Whittington somewhat perplexed, but this episode of amusement at the staid gathering in fact marked the beginning of a new phase in paleontology. Whittington had brought his audience face to face with the strangeness of the Cambrian diversification. Our current understanding of the diversity of form among Cambrian animals is a direct result of Whittington's research programme.

In his letter to Stephen Jay Gould (1 March 1988) regarding the Burgess monographs, Whittington reminisced that "perhaps these necessarily dry papers conveyed a little of the excitement of discovery—it certainly was an intriguing investigation which had its moments of great joy when a new and unexpected structure was revealed by preparation." In an epic clash of intellect that followed (culminating in a live debate at Yale University), Gould and Conway Morris crossed swords over interpretation of the Burgess Shale fossils. Gould argued in *Wonderful Life* that the kaleidoscopic disparity of the Burgess oddities would have rendered it impossible in principle to select a winner in the struggle for survival. Gould concluded that chance is all, contingency rules history, and that, ultimately, it is up to us alone to impart meaning to the whole.

Conway Morris, in pointed contradiction to Gould's scheme, documented (*Crucible of Creation, Life's Solution*) the theme of repeating pattern in the kaleidoscopic vista. For Conway Morris, the ubiquity of convergent evolution in the history of life speaks of regularity, even predictability to the overall pattern. It now seems clear, however, that neither Gould's random contingency nor Conway Morris's purposeful inevitability, both of which take the Burgess Shale as their starting point, adequately addresses the confounding suddenness of the Cambrian event.

At the end of his insightful book *The Burgess Shale* (1985), Whittington emphasized the abruptness of the Cambrian event, and in the last line he noted that "we are far from explaining the evolutionary pathways that coincided there, or those that lead from it." This remains true today. Whittington stressed, as Stefan Bengtson said in his review of the book, the fact that the "shale holds many embarrassingly modern looking organisms". This modern aspect was subsequently underscored by discovery of the Cambrian fish *Myllokunmingia* from Chengjiang, China. And in a remarkable reinterpretation appearing in May 2010, Martin Smith and Jean Bernard Caron reconstruct the Burgess Shale problematicum *Nectocaris* as a squid – like, soft bodied cephalopod.

Even if we accept Ediacaran fossils such as *Spriggina* and *Kimberella* as Proterozoic ancestors of trilobites and molluscs, respectively, the speed and phylogenetic magnitude of the Cambrian diversification strains the credibility of arguments that attribute the event to slow accumulation of microevolutionary change. The discoveries of *Nectocaris* (cephalopod) and *Myllokunmingia* (fish) in Early Cambrian strata render the evolutionary conundrum considerably more acute. Simon Conway Morris speculates that we may be entering some sort of post Darwinian world. Any kind of post Darwinian world that we might imagine must provide an adequate explanation for the Cambrian event.

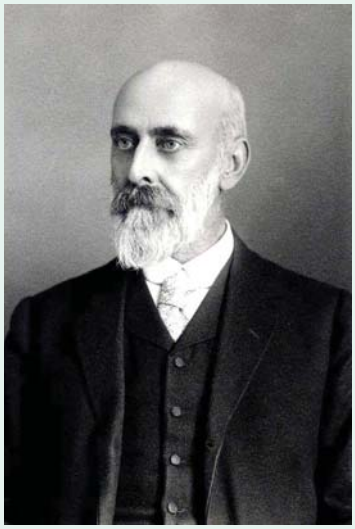
Perhaps Whittington's greatest scientific legacy is that he leaves us with tools and guideposts that will direct us to solutions, if any may be found, to the Cambrian problem. We must follow the evidence where it leads. Harry Whittington leaves us an inspirational record as paleontologist and world class mentor who led by example and coordinated an astonishing burst of new discovery.

Mark McMenamin

DISTANT THUNDER

Cat flap

Geologist and science writer Nina Morgan reports on how one geological museum dodged the austerity measures and clubbed together to preserve an essential service.*



With government spending cuts looming, museum directors are faced with some difficult decisions about how to reduce spending while still maintaining essential services. This sort of situation is far from unique. In his book *A Hand Through Time*, Edward Greenly, a geologist who enjoyed a long career with the Geological Survey that included some memorable mapping experiences with the Scottish Survey in the late 19th Century with Benjamin Peach and John Horne in the NW Highlands, describes how Sir Jethro Justinian Harris Teall (picture), Director of the Geological Survey from 1901 – 1914, handled just such a sensitive situation.

The victim threatened by the funding cuts was a valued member of staff – the Museum Cat. Described by Greenly as 'black, silent and solemn' and with 'great green eyes' the Museum Cat was employed to keep down the mouse and rat population in the now vanished Geological Survey Museum on Jermyn Street in London. The Cat's office was, wrote Greenly, not a sinecure. "Lunch is taken in the building, crumbs are dropped, and stores are kept, mice and rats would soon invade. He [the cat] accordingly, is a Civil Servant: H.M.M.C. = His Majesty's Museum Cat. Nor does he work without salary: among the regular pay-bills presented to the Chief is the pay-bill of the Cat.

As the result of an economy drive, Greenly reports with some regret, that the British Government 'defaulted' when it came to paying the bill. "I was told by Teall of a 'minute' from the Treasury: owing, it ran, to the heavy cost of the war in south Africa, the salary of the Cat could not be paid."

Sacking the Cat was unthinkable, he continues. But fortunately Teall came up with an alternative solution. Teall "appealed to the whole of the Staff" Greenly reveals, "and the [Cat's] salary was subscribed for the remainder of the war, after which the Government discharged once more its obligations". Purrfect!

There must be a lesson for Messrs Cameron, Osborne and Clegg - or maybe the rest of us - here somewhere.

Reference

The story of the Museum Cat appears in *A Hand through Time: Memories – Romantic and Geological; Studies in the Arts and Religion; and the grounds of Confidence in Immortality*, by Edward Greenly, (in two volumes) Thomas Murby & Co. 1938

A HOGG conference on Geological Collectors and collecting is planned for 4-5 April 2011 at the Natural History Museum, London. To receive further information and announcements about the conference, E: ninamorgan@lineone.net

Geological museums and collections will be one of the discussion points at the HOGG conference on Geological Collectors and collecting to be held on 4-5 April 2011 at the Natural History Museum, London. To receive further information and announcements about the conference, E: ninamorgan@lineone.net

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

If the past is the key to your present interests, why not join the History of Geology Group (HOGG)? For more information and to read the latest HOGG newsletter, visit the HOGG website at: www.geolsoc.org.uk/hogg.

New JGS Production Editor

Dawne Riddle writes: The Society is pleased to welcome Hannah Sime to the Publishing House team. Hannah has taken over the management of *Journal of the Geological Society* from Angharad Hills. Angharad, who has managed *JGS* for 25 years, will now spend more time on commissioning new book titles and managing books through to production. Hannah and Angharad will also work on book production.

All *JGS* editorial and production enquiries should be sent to Hannah (hannah.sime@geolsoc.org.uk; 01225 476411). Enquiries about your copies of the journal or access to the online journal should be addressed to the Fellowship Office (enquiries@geolsoc.org.uk; 0207 434 9944).

Not just "Another Year"

Paul Maliphant FGS CGeol (Halcrow), Chair of the South Wales Regional Group, tells Geoscientist *how he became involved in the film industry…*


Mike Leigh, Director

Secrets and Lies, Nuts in May, Abigail's Party, Happy-Go-Lucky - titles of films by director Mike Leigh read like a list of the peaks in British TV and cinema, lately sweeping off with high profile awards like the *Palme d'Or* with his gritty, social-realist portraits of ordinary people in ordinary – and sometimes highly extraordinary - circumstances.

On general UK release this month and filmed under strict secrecy, Leigh's latest film is *Another Year*, and stars one of his regular leading men, Oscar-winning British actor Jim Broadbent, as 'Tom', an engineering geologist working for Macfadden Belcher - a (heavily veiled) portrait of Paul's employers.

"I attended a meeting at the Geological Society in London, where I met Jim's assistant searching the Society website for contacts to help him develop his character" Paul told *Geoscientist*. "I was convening a field trip in Wales just then and they contacted me to see if he could join us."

Leigh is famous for his unique method of working, which involves the actors in detailed research, to flesh out their characters as the script evolves. Leigh's scripts are largely improvised, so it is vital that all his actors have an in-depth understanding of their characters' backgrounds.

"I arranged for Jim to have dinner with a former colleague whose career matched the early stages of Tom's – namely, mineral exploration in Australia in the early 70s." On the field trip, Paul and Jim discussed aspects of geology and the events that may have moulded his character. "I took him to the Aberfan memorial and cemetery, as the disaster would have occurred during his first term at university" says Paul. The field party also visited the Church Village bypass, on which Halcrow had conducted early geological work. Following the visit, both Jim and the director decided that Tom had worked as a geologist on the construction of the M25, and through Paul's contacts, Jim got in touch with a geologist from another consultancy who had done precisely that.

The director decided that Jim's character had joined Mcfadden Belcher in 1985, so Paul arranged for Jim to meet Halcrow engineering geologist Colin Warren to gain an insight into life during that period. A second geologist character, also working for Mcfadden Belcher, is played by Stuart McQuarrie (*Trainspotting, 28 Days Later*). He joined Paul and Jim for a day's geology masterclass in South Wales.

> *"we were on location from 7.30am till 6.30pm to devise, write, rehearse and film the complete scene - which may last on screen for no more than two minutes"*

Paul was asked to advise the producers on what other professionals Tom might have come into contact with. They decided that another character, Jack, played by Phil Davis (*Quadrophenia*), would be a surveyor. Paul put the team in contact with Chris Kelly, a Chichester-based technical director for Halcrow, who provided the character insight for this part. Chris in turn


Broadbent and Maliphant

Paul explains triaxial indicatrix. Jim tries to stop jelly falling off ceiling.

Jim Broadbent, Ruth Sheen and Oliver Maltman

arranged for the actor to visit Swindon's Chisledon Washpool, another Halcrow project. He was joined by Reading surveyor, Richard Small, who demonstrated the basic elements to the art of surveying and how to use the instruments.

Says Kelly: "I helped them with background, as they needed someone who was a working surveyor in the early 1970s – I'm probably the only one old enough! They had some misconceptions about how you would qualify to be a surveyor, which I was able to put right. It wasn't through university back then - rather through the technical side, with the Royal Institute of Chartered Surveyors." In the film, Phil's character broadly follows the same career path as Chris. "They wanted to know what type of work we did back then, how it fitted in with your life, as you had to move around a lot, and how this affected relationships" says Chris.

Typical of Mike Leigh's improvisatory methods, the film's title was only decided after it was in the can. During production, Leigh frequently creates detailed improvisations, sustained over a period of weeks, to develop both characters and storylines. Intimate moments are explored that may have no direct bearing on the final film, but to help the cast build insight and understanding of the history between their characters and inner motivations. Critical scenes in the final story are performed and recorded in costume – themselves real-time improvisations, where the actors encounter new characters for the first time, events or information which may dramatically affect their lives.

Such pivotal moments may play out with only some of the actors being fully aware of the action to follow, allowing Leigh to capture the others' genuine, unrehearsed reactions. Final filming follows a more traditional path with a defined sense of story, action and dialogue. Paul saw this method of working at first hand when he was invited to attend a shoot at Battersea Power Station and meet the rest of the cast and crew. In his bid to give an accurate portrayal of the period, Mike Leigh turned to Paul for advice.

"The scene included a lorry-mounted rotary drilling rig set up over a 2.5m-deep mocked-up borehole" says Paul, who even had a hand in the script-writing. "We decided the rig was required for a tunnel and we worked out the details of the proposed borehole and the reasons why the geologist characters had to visit the site." Paul went on to advise on costumes, the use of company logos and the number and type of vehicles required. "Overall, we were on location with a crew of 65 from 7.30am till 6.30pm to devise, write, rehearse and film the complete scene, which may last on screen for no more than two minutes!" says Paul.

- *Another Year* will on general release this month. See p. 14 for a Review by Sarah Day.

Dryas dust research reveals no impact

The Younger Dryas Impact Theory suffers yet another blow, reports Dwain Eldred

Diamonds might be a girl's best friend but they are doing no favours to the now widely discredited "Younger Dryas Impact" theory, as a team of scientists casts serious doubt upon the last remaining un-debunked evidence in support the hypothesis.

Just 12,900 years ago, gradual warming following the last Ice Age came to a halt, and glacial conditions were restored for a 1300-year interval known as the Younger Dryas. In North America, many large species (mammoths, mastodons, sabre-tooth tigers, giant short-faced bears) became extinct. A controversial theory has suggested that a comet or meteor airburst or impact may have been responsible.

In sedimentary deposits dating to the beginning of the Younger Dryas, proponents of this theory had reported carbon spherules containing tiny nano-scale diamonds, including lonsdaleite, a rare hexagonal (2H) diamond polytype, often associated with shock pressures related to impacts where it has been found to occur naturally.

However in a paper published by the Proceedings of the National Academy of Sciences (PNAS), a team of scientists shows that the original material reported as diamond appears to have been misinterpreted, and also that what had been previously reported as nanodiamonds are instead forms of carbon related to common graphite.

Dr Tyrone Daulton (Washington University in St. Louis) commented, "Of all the evidence reported for an Younger Dryas impact event, the presence of 2H hexagonal diamond in Younger Dryas boundary sediments represented the strongest evidence suggesting shock processing."

However, close examination of carbon spherules from the Younger Dryas boundary using transmission electron microscopy found no nanodiamonds. Instead, graphene- and graphene/graphane- oxide aggregates were found to be ubiquitous in all specimens examined (including carbon spherules dated from before the Younger Dryas to the present). Importantly, previous studies were shown to have misidentified graphene/graphane- oxides as hexagonal diamond and probably also misidentified graphene as cubic diamond.

The Younger Dryas impact hypothesis was already in trouble before this latest finding – as reported earlier this year. Many other lines of evidence – including fullerenes, extraterrestrial forms of helium, purported spikes in radioactivity and iridium, and claims of unique spikes in magnetic meteorite particles – had already been discredited. According to co-author Professor Nicholas Pinter (Southern Illinois University) "nanodiamonds were the last man standing."

Another report co-author Professor Andrew C. Scott (Royal Holloway, University of London), told *Geoscientist*: "we should always have a sceptical attitude to new theories and to test them thoroughly, and if the evidence goes against them they should be abandoned".

Reference

- Daulton, T *et al.*, August 2010. No evidence of nanodiamonds in Younger-Dryas sediments to support an impact event. Proceedings of the National Academy of Sciences, doi/10.1073/pnas.1003904107

IN *Brief*

Map app

The latest manifestation of William Smith's Really Big Idea – the geological map – emerged from the British Geological Survey on 23 September, when it released through the Apple Store a free iPhone/iPad app (www.bgs.ac.uk/iGeology/home.html?src=sfb). This app provides GPS-located access to BGS's 1:50,000 scale geological mapping through a web service. Click on a polygon and it will tell you what rocks or superficial deposits are beneath your feet, with further links to the BGS website should you want to – as it were - dig deeper. A similar android app is under development and will be released as soon as possible.

Society climate change statement

Stop pulling the carbon trigger, says Society President

The Society has published a statement about the geological evidence relating to past climates, atmospheric carbon levels, and their inter-relationship (p24). The online version also carries a list of recommended further reading.

Dr Bryan Lovell, President, told *Geoscientist*: "Climate change is a defining issue of our time, whose full understanding needs geology's long perspective. Earth scientists can read the geological record of changes in climate that occurred long before we were around to light so much as a camp fire, let alone burn coal, gas and oil.

"A dramatic global warming event 55 million years ago gives us a particularly clear indication of what happens when there is a sudden release of 1500 billion tonnes of carbon into Earth's atmosphere. It gets hot, the seas become more acid, and there is widespread extinction of life. We are a third of the way to repeating that ancient natural input of carbon through our own agency. The message from the rocks is that it would be a good idea to stop pulling that carbon trigger."

Dr Colin Summerhayes, the statement's lead author, added: "The world has been cooling and losing CO_2 from the atmosphere for the past 50Myr. Thirty-four million years ago that process led to the first large ice sheets on Antarctica. During the Ice Age, [fluctuating] solar radiation [caused] alternating glacial and interglacial periods. These changes… were accentuated by the release of CO_2 and water vapour to the atmosphere from the

EDUCATION NEWS

Over 100 Schools link to the Geological Society

Jo Mears writes: The Geological Society is delighted to announce that over 100 schools have now joined its new Schools Affiliate Scheme. Open to all schools within the UK, it aims to provide support to those schools wishing to understand more about Earth sciences and how to incorporate examples of the subject within the National Curriculum. For further information, please contact joanna.mears@geolsoc.org.uk

Geoscience Education Academy 2010

This August, with generous support from BP, the Geological Society was able to run its first residential Geoscience Education Academy at Burlington House for over 20 teachers, who came principally from chemistry, physics or biology backgrounds.

The GEA was designed to help those who do not necessarily teach geology as their main subject, but who do so as part of the national curriculum. In addition, it provided the Society with a useful link and direct insight into the pressures and issues surrounding today's science teachers.

Working in partnership with the American Geological Institute (AGI), who run several similar courses in the USA each year, teachers were able to meet a 'real' geologist, visit the Electron Microscopy and Mineral Analysis department at the Natural History Museum, share ideas with one another and come away with a plethora of lesson plans and access to a wide variety of online resources. *JM*

- For further information on next year's GEA, please contact Joanna.mears@geolsoc.org.uk

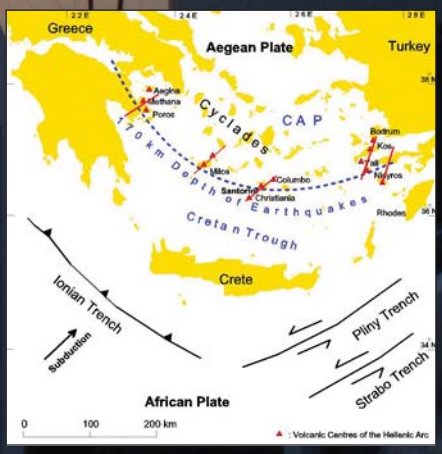
warming ocean, and by shrinking sea ice and northern hemisphere ice sheets - reflecting less [heat] back into space.

We are living in an interglacial, but as Summerhayes says: "During parts of the previous interglacial, 130,000 years ago, polar temperatures reached 3-5°C above today's, and global sea levels were around four to nine metres higher than they are now. The message from ice cores is that continued emissions may be expected to lead to warming and sea-level rises similar to those of the last interglacial period – something we would be wise to avoid."

The statement was reviewed by the Society's External Relations Committee, (Chair, Prof Alan Lord) before being adopted by Council. It was also reviewed independently by palaeoclimate expert Prof Peter Barrett FRSNZ, of the Antarctic Research Centre, Victoria University of Wellington (New Zealand). The Statement was written by a group of acknowledged experts including: Dr Colin Summerhayes FGS (Chairman, Vice-President GSL; Scott Polar Research Institute, Cambridge University); Prof Joe Cann FRS FGS (School of Earth and Environment, Leeds University); Dr Anthony Cohen FGS (Department of Earth and Environmental Sciences, The Open University); Prof Jane Francis FGS (School of Earth and Environment, Leeds University); Dr Rob Larter FGS (British Antarctic Survey, Cambridge); Prof John Lowe FGS (Department of Geography, Royal Holloway University of London) and Prof Nick McCave FGS (Department of Earth Sciences, Cambridge University). Other experts consulted were Dr Alan Haywood (School of Earth and Environment, Leeds University); Prof Paul Pearson (School of Earth and Ocean Sciences, Cardiff University) and Dr Eric Wolff FRS (British Antarctic Survey, Cambridge).

Santorini run

In the second of this short series on holiday volcanic islands, geologist and runner Nigel Platt remembers Santorini.



South Aegean volcanic arc and tectonic setting of Santorini after Friedrich 1994 decadevolcano net

A cold January in London is always the perfect time to head inside. One such Sunday found us at the British Museum, gazing at a small statue that transported us to a different world. Inside the case, an acrobat was jumping over the horns of a charging bull — a feat of agility captured in Bronze Age craftsmanship more than three and a half thousand years ago.

And so we decided on Santorini. A few short months later, it was early morning and the sun was already hot across the blackness of the beach. To the south, the road snaked its way up the cliff to Ancient Thera. It's one of the most beautiful places on Earth; but the climb of Mesa Vouno would have killed me long before I got there. So instead, I headed north along the shore, the Aegean on my right, and work my way slowly out of the resort of Kamari. The strip was quiet at that time; just a few old folks up, foraging for breakfast. The rest were sleeping off the night before. The deserted hotels and bars fell swiftly behind, and soon I reached the end of town and the start of Greece.

It's peaceful running here. Beside the road, straggly vines drape across the ground, Santorini-style. I trot past a cluster of pines, round a corner, and a vista opens. Beyond the airport to my left, the horizon rises evenly through sparse brown fields. The white town of Pyrgos stands atop the hillside, looking out to Fira on the crater rim, and the tourist trail to Oia. Nothing is flying yet, though a few cars drift past, carrying holiday workers to their travel agencies and hotels. Ten minutes go by as the day grows warmer and my legs steadily measure out the long road beside the runway.

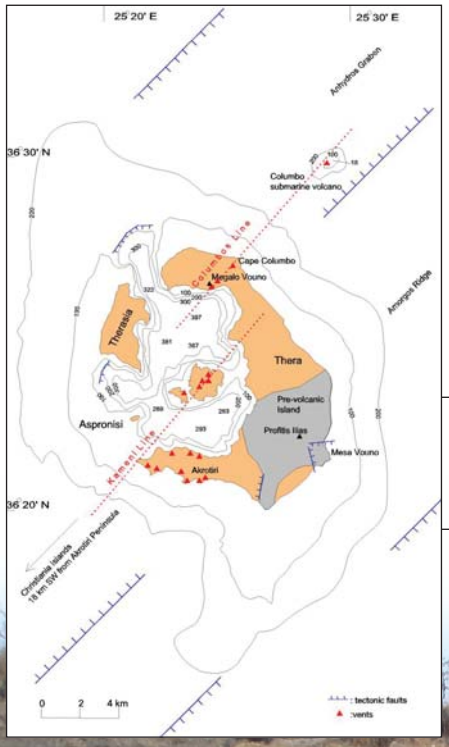
The church of Agios Ioannis (St John) lies up ahead. Not far beyond lies the pretty beach of Monolithos, with Vourvoulos hidden further on. Quiet, dreamy hideaways these, floating in the forgotten corners of a tourist island — yet still recalling the violent history of this place. Because this landscape, between Ancient Thera, Pyrgos and Monolithos, formed around a smaller, older island that was buried by a series of cataclysmic eruptions throughout the past 200,000 years.

The road to Vourvoulos cuts through cross-bedded volcaniclastics, stuffed with vicious-looking volcanic bombs, each more than big enough to kill a man. Dating from an early eruption, these rocks fell long before recorded human history. The main event occurred 40,000 years later, around 1645BC, when the Minoan civilisation ruled the eastern Mediterranean. But their archaeological record is scant, perhaps consistent with the geological catastrophe that destroyed their power.

Even the eruption of Krakatoa in 1883 scarcely holds a candle to events on Santorini, where the start of the main eruption saw the ejection of an ash column 36km high, covering the island in a blanket of pumice up to five metres thick and spreading an ash cloud all around the Eastern Mediterranean.

A second phase saw boiling pyroclastic flows spread out across the ground at up to 180 kilometres per hour. The flows were 10m thick and draped relief up to 400m high. Seawater breaking into the crater set off violent phreatomagmatic explosions, sending huge angular chunks of basalt high into the sky and raining back to Earth. Yet more ash fell up to 40m thick around the crater edge in the third eruptive phase — these rocks containing clasts up to 10m across. Finally, reworking of material from the eruptive cone laid down clastic fans up to 40m thick across the coastal plains.

In all, the eruption saw the extrusion of at least 35 cubic kilometres of rock. The sound of Krakatoa was heard 5000km away, so we can assume that the Santorini blast echoed across the ancient world. Surrounding coasts were probably devastated by terrible tsunamis. Throughout the Aegean and eastern Mediterranean, it would have been dark for days (or even weeks, or months) as the ash cloud spread east and southeast on the prevailing wind. On Santorini, the eruption buried the Minoan settlement at Akrotiri in a thick layer of pumice. Further beyond, in Crete, tsunami damage to harbours and ships may be one reason for a dramatic weakening in the Minoans' wealth and influence, which led to their conquest by the Myceneans not many years after.

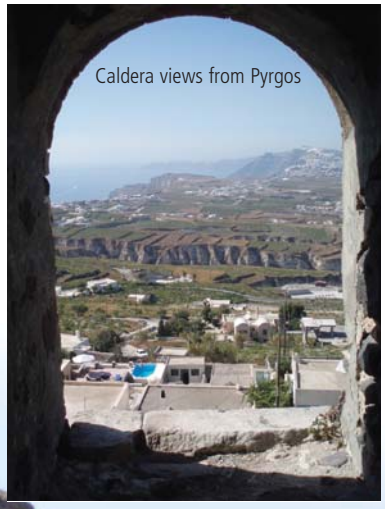


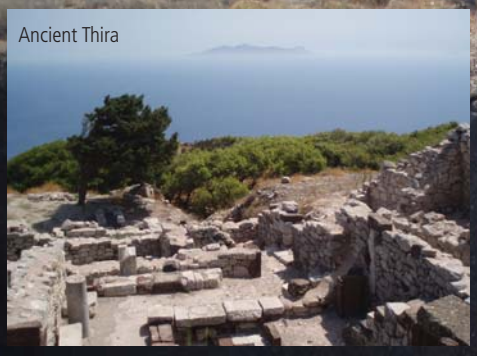
Caldera and structural setting of Santorini after Heiken & Mccoy 1984 decadevolcano net

I climb the hill to the church, and look out across a blue expanse of Aegean Sea. Minoan trading ships called here, 4000 years ago. After the Myceneans came the Dorians, who founded 'Ancient' Thera around 900BC. Then came Greeks, Spartans, Romans (later Byzantines) and Franks. The Venetians named the island for Saint Irene. Then the Ottomans arrived, before Santorini gained independence in 1821 and joined Greece nine years later. I turn and gaze back. New visitors fly here now, not in conquest but to witness some of the most spectacular sunsets on Earth.

The pretty towns on the ridge surrounding the caldera are as beautiful as anywhere I have seen, their outlook made all the more majestic by views of the slowly rising fresh volcanic island of Nea Kameni, far below. A new shield volcano is steadily building there - towards Santorini's next devastating eruption.

I kick my heels again, down past the airport and back beside the beach. The heat of a Greek summer's day is building through five hot kilometres to Kamari, and my legs tire with every footfall. Another day can start now, beside the pool in the morning and an afternoon swim at Monolithos. The memory of a hot 10km run on Santorini will brighten some future London winter's morning like Keats's "beaker, full of the warm south". ☙


Caldera views from Pyrgos


Ancient Thira


Thira from the Caldera

Review

Another Year

Released by: Momentum Pictures
Writer/Director: Mike Leigh
Starring: Jim Broadbent, Lesley Manville, Ruth Sheen, Oliver Maltman, David Bradley, Peter Wight, Phil Davis, Imelda Staunton
Running time: 129 minutes
UK Certificate: TBC (USA – PG-13)
UK General Release: 5 November

"The geologist stands on the beach with his back to the sea, looking at the cliffs."

"And the geologist's wife stands with her back to the cliffs, looking at the sea."

Another Year is a title no-one but Mike Leigh could get away with, and he does it in style. There's a geologist's sense of time to the premise of the film – it records events, not because they are particularly significant or catastrophic, but because they provide a snapshot of what life is like in a particular place, at a particular time, in meticulous detail.

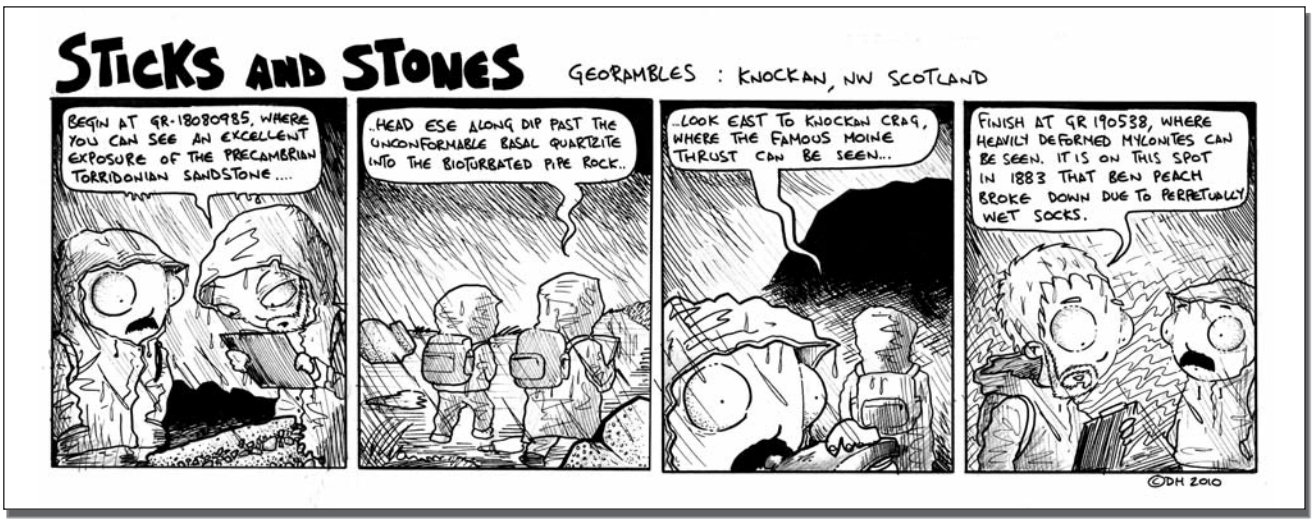
Tom and Gerri are one of life's 'happy couples' - those people who invite you to dinner a lot, and make you feel slightly insecure about your own life. They're allotment people, the sort of people who send you outside the back door to smoke but are terribly nice about it, who drink buckets of wine but never get drunk (except in a chatty, intelligent sort of way) and who can at once be incredibly kind, and incredibly patronising.

More importantly for this magazine, Tom is a geologist – not the volcano-chasing hero-geologist or the idealistic, truth-seeking palaeontologist types that will be familiar to film audiences , but an engineering geologist working on London's ageing sewer system. Leigh and Broadbent's research for the part, as Paul Maliphant's article on page 7 outlines, was painstaking, and it shows. Not only is the 'Macfadden Belcher' scene, complete with high-viz jackets and industrial machinery, entirely believable, but Tom's character is spot on – he giggles with delight as a core sample of London clay is presented for his inspection, and makes all the right sort of 'I dig holes for a living' jokes, while his wife bemoans his interest in strata on their holidays.

He is also one of the film's rare 'happy' characters - as is Gerri, a medical counsellor. Other professions fare less well – Mary the medical secretary is on the point of a breakdown for most of the film, while Ken the civil servant can't seem to get over the fact that time has moved on, and everything around him has changed. There's a slightly worrying suggestion that singledom is at the root of their problems, and that it is in each other that Tom and Gerri have found happiness. But Leigh's argument is really about the lottery that is 'being happy' – some people find what they're looking for, and some don't. The ones that do seem to find much of their happiness in their work – as Tom's son's new girlfriend Katie, an occupational therapist, tells him: "It's nice to go home at the end of the day and feel you've contributed to something".

Like all Leigh's work, *Another Year* is beautifully understated. The stand-out performance is Lesley Manville's Mary. Everyone has a friend like Mary, blissfully unaware that their thin veneer of bubbly happiness isn't fooling anyone. Her eventual collapse is both real and inevitable, and Leigh bravely makes no attempt to suggest there is anything good waiting around the corner for her. Despite moments which some might find a little too bleak, or even stereotypically so – Tom's taciturn, bereaved Northern brother, for instance – the film also manages to be very, very funny. And the good news for geologists in the audience is that, in the mike Leigh happiness-lottery equation, the geologist comes out on top.

Sarah Day



Letters

Geoscientist welcomes readers' letters, and every effort is made to publish them as promptly as possible. You can help by keeping letters to around 300 words or fewer. Please write to **Dr Ted Nield,** Editor, at The Geological Society, Burlington House, Piccadilly, London W1J 0BG or email ted.nield@geolsoc.org.uk.

All letters are published at **www.geolsoc.org.uk/letters,** and a selection subsequently presented in the magazine. Please note that letters may be edited.

NERC needs to know

From Mark Thorley and Jeremy Giles (Rec'd 3 September 2010)*

Sir, Tracing and understanding past environmental change plays an important role in the prediction of future environmental change. The data held by Natural Environment Research Council (NERC) consists of historical records accumulated over decades that provide a valuable resource to support research, survey and monitoring activities and for users in academia, government, the public sector, industry and commerce. The NERC data centres (www.nerc.ac.uk/research/sites/data/) are responsible for the long-term management of data and provide access to NERC's data holdings. They also provide support and guidance in data management to NERC funded researchers.

The NERC has recently launched a new Science Information Strategy (www.nerc.ac.uk/research/sites/data/sis.asp). It has been created to provide the framework for NERC to work more closely and effectively with the scientific communities, both internal and external, in delivering data and information management services to support its five year science strategy, the Next Generation for Planet Earth (www.nerc.ac.uk/about/strategy/ngscience.asp).

A key part of working more closely and effectively with the scientific community is understanding the requirements and expectations of existing users, as well any barriers or obstacles that can prevent other people from becoming users. To this end NERC will be seeking the views of the wider community to discover if the activities of the NERC data centres are meeting their needs.

The views of existing and potential users are extremely valuable and we would ask that you take a 10 to 15 minutes to take part in the consultation. The result of the initial consultation will provide valuable information to help us plan for future developments and will be the foundation for further dialogue. The initial consultation is by means of an online questionnaire which will be available between the 15 October and the 19 November 2010. It can be found at www.nerc.ac.uk/research/sites/data/consultation.

During the initial online questionnaire you will be asked to indicate if you would be willing to take part in a subsequent phone interviews, this is entirely voluntary.

The results of the study will be made available through the NERC website early in 2011.

* Natural Environment Research Council

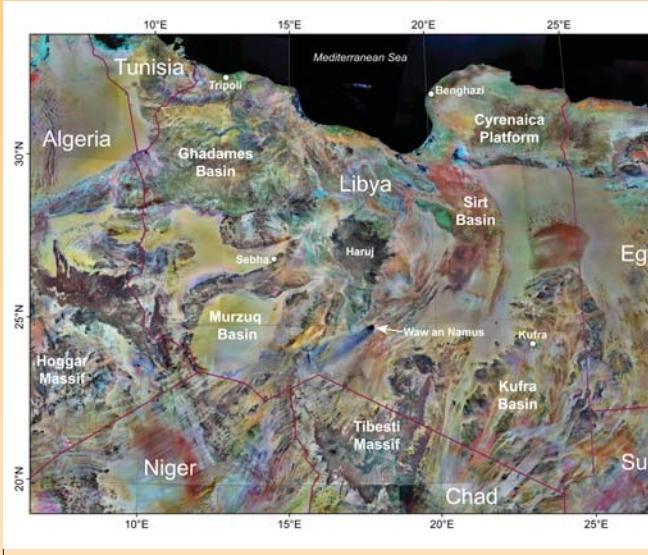
Geological fieldwork in the Lib

Guido Meinhold and Daniel Paul Le Heron describe the geology of one of hydrocarbon-rich countries, together with the joys – and rigours - of wor*

Libya is one of the most hydrocarbon-rich countries in the world. Its large oil and gas reserves make it attractive to international oil companies, which provide the impetus for field-based research in the Libyan Sahara.

Libya is bounded to the north by the Mediterranean Sea, to the east by Egypt, to the south by Sudan, Chad and Niger, and to the west by Algeria and Tunisia. At approximately 1.8 million square kilometres, Libya is the fourth largest country on the African continent, or about seven-times the size of Great Britain, but has only a tenth of the population (six million).

This is perhaps not surprising as about 90% of Libya belongs to the Sahara: one of the hottest and driest places on Earth. The excitement of exploring this remote and often dangerous landscape has attracted several generations of geologists. Between 1920 and 1940, the famous Italian geologist Ardito Desio Hon FGS (1897-2001) set important milestones, producing the first geological map of Libya, discovering the trace fossil *Bifungites fezzanensis*, and initiating the oil and gas exploration in Libya. Libya is now regarded as a global hotspot for hydrocarbon exploration.



Landsat image showing Libya and surrounding areas (Source: http://zulu.ssc.nasa.gov/mrsid).

How Libya was made

North Africa is made up of several enormous intracratonic basins, two of which are found in southern Libya. The Murzuq Basin, in the southwest, and the Kufra Basin, in the southeast, together cover almost 800,000 km^2: about 3.5 times the total land area of the UK. Both basins are filled with Palaeozoic and Mesozoic clastic sedimentary rocks up to five kilometres in thick. These basins developed from the Cambrian onwards following an earlier period of orogenesis (the Panafrican Orogeny) in the Neoproterozoic (~900–540 million years ago).

Precambrian metasediments and granitoids are unconformably overlain by Cambrian and Ordovician conglomerates and sandstones. They show a transitional environment from continental to shallow marine. Sandstone bearing the trace fossil *Skolithos* is common in Ordovician strata. During the Middle Ordovician, an ice sheet began growing on Gondwana, reaching its climax during the Late Ordovician. Melting of this ice sheet in the latest Hirnantian (about 445 million years ago) released large amounts of meltwater and sediment, which were transported to the periphery of Gondwana. In Libya, these sediments are predominantly highly mature sandstones, which in many places form excellent

Bifungites fezzanensis Desio from west-central Libya. The genus name this trace fossil is based on its double mushroom-like shape; the speci name is after the Fezzan area of the Murzuq Basin. *Inset* – Ardito Des as a young man. You can read Professor Richard Selley's obituary of D (2001) at www.geolsoc.org.uk/obituaries.

hydrocarbon reservoirs. Polished and striated surfaces in these sandstones clearly point to their glaciogenic origin.

Following Late Ordovician deglaciation, black shale deposition occurred in the Silurian, with some of the shales being characterised by high organic carbon. These shales are commonly referred to as 'hot shales', and are the major source rock for Early Palaeozoic-sourced hydrocarbons in North Africa. Both the Late Ordovician glaciogenic sediments and the Early Silurian 'hot shales' are hence a main focus of geological research in the Libyan Sahara. Fluvial conglomerates and sandstones of Devonian age, which occasionally contain plant fossils, unconformably overlie these strata. Further up in the Devonian, marine intervals are more common, and the Carboniferous is characterised by shallow marine clastic sediments with carbonate horizons. Permian rocks are only known from subsurface drill cores and comprise continental and deltaic facies.

Panafrican basement in southern Libya, a few kilometres north of the border with Chad.

Skolithos-bearing sandstone of the Middle Ordovician shallow marine succession.

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In the basin centres, the Palaeozoic succession is concealed by up to three kilometres of Mesozoic–Cenozoic strata. The lack of vegetation means that satellite images often provide spectacular insight into the geology. For example, huge volcanic centres of Miocene to Pleistocene age can easily be mapped throughout Libya, from the western margin of the Kufra Basin (Tibesti Massif), northwest toward the Al Haruj volcanic province in central Libya, and further still to the Nafusa Mountains south west of Tripoli. The most famous volcano of all is Waw an Namus in south-central Libya. Its name translates as 'Mosquito Crater', which perhaps needs no further explanation. Waw an Namus sits in a caldera c. four kilometres in diameter, with three salt lakes in the centre. It is surrounded by a field of black tephra and has an ash tail that extends about 140km to the southwest, providing evidence for palaeowind direction during the eruption.

Today, the Libyan Sahara is one of the most hostile places on Earth. Yet several thousand years ago, the situation was very different. Along the shorelines of mega-lakes, lush vegetation allowed a diverse fauna to flourish. These included buffalo, gazelle, giraffe, elephant, crocodile, ostrich and many others. Prehistoric artefacts and stone carvings show that early modern humans wandered around the Libyan Sahara more than 100,000 years ago, admiring and hunting these beasts.

Squeezing information from rock

Understanding the timing of basin formation and important phases in early basin evolution (e.g. development of unconformities) is important in shedding light on whether the Early Palaeozoic basin succession is really "layer cake" or more complex. Knowledge of these processes is essential to understand both the development of the intracratonic "sag basins", and critical in working out time of

Waw an Namus volcano in south-central Libya.

Sandfield at the western margin of the Kufra Basin.

Ancient carving in southern Libya, a few kilometres north of the border with Chad.

Late Ordovician glacially-related sandstones with polished and striated surfaces.

formation for potential hydrocarbon traps. Also important is the search for source rocks. Because most of the Early Palaeozoic succession in southern Libya is largely barren of fossils, heavy mineral chemostratigraphy must be used for correlating surface outcrops in the Kufra and Murzuq basins.

Many boreholes have been drilled in the Murzuq Basin over the last 50 years; seismic data have been collected and hydrocarbon reserves are proven (in complete contrast to the Kufra Basin). While draas and large dune fields pose a challenge to any exploring field geologist, excellent exposures occur at the basin margins. Besides the investigation of outcrops, samples are collected for heavy mineral provenance, source-rock analysis and biostratigraphy. Isotopic analysis (e.g. U–Pb dating on zircon crystals) is used to constrain the age of the Precambrian basement and the overlying sedimentary strata, and to better understand sediment transport paths across North Africa. Extensive sample collection provides a solid base for follow-up analyses. Unfortunately, all outcrop samples are heavily weathered, making collection of fresh specimens very difficult. However, the drilling of shallow boreholes (c. 70m) can overcome this.

Desert exploration

There are two time-windows when Saharan fieldwork is possible: February-April, and October-December. During these months, the temperature does not normally exceed 30°C, although the nights can become very cold and windy. In April, ferocious sand storms become quite common.

If you don't want to travel by camel (or walk!) then the only way to get about is by 4WD. An ideal set-up is a small group, comprising two or three vehicles: one for the geologists and equipment, and the other for food, fuel and – the most important of all – water. Small means flexible: any campsite can be moved and set up in very short time. Aspiring Saharan geologists should set up camp in daylight and never at night because snakes and scorpions make uncomfortable company in your

sleeping bag. These desert inhabitants are some of most dangerous animals you might encounter. Snakes normally escape before you even see them. Scorpions are more problematic. They hide under rocks and do not move when you approach them. Rocks should always be moved with a hammer or a fully booted foot.

The other worrying issue is unexploded landmines, which are found not only at the borders with Chad and Niger but also in central Libya, north of the Tibesti Massif. It can be an unsettling experience to drive along a previously "forbidden road", as marked on your official road map, as we did in April 2009. Finally - the intense sunlight makes it imperative to cover up in light-coloured clothes with long sleeves, a sun hat, and plenty of sunscreen. It is also important to drink small amounts of water at regular intervals, since dehydration leads to irreversible damage to internal organs.

Despite all of this, by following some simple rules and being aware of possible dangers, you can easily enjoy life in the desert - much of which is virgin geological territory with stunning scenery. After traditional Libyan stew and couscous, you will reflect on the day's adventure with a glass of green tea. Sleeping in the open air on the desert sands, you will count shooting stars in the sky and during the long nights, plan the next productive field day in the Libyan Sahara.

Acknowledgements

This work is supported by the Libyan Petroleum Institute and the Earth Science Society of Libya, and funded by a consortium of subscribing oil and gas companies. All of them are gratefully acknowledged for their support of the Southern Basins of Libya study.

Further reading

- Hallet D 2002. *Petroleum Geology of Libya.* Elsevier, Amsterdam, 1–508.
- Le Heron DP, Craig J and Etienne JL 2009. *Ancient glaciations and hydrocarbon accumulations in North Africa and the Middle East.* Earth-Science Reviews, 93, 47–76.
- Lüning S, Craig J, Loydell DK, Štorch P and Fitches B 2000. *Lower Silurian 'hot shales' in North Africa and Arabia: regional distribution and depositional model.* Earth-Science Reviews, 49, 121–200.
- Tawadros EE 2001. *Geology of Egypt and Libya.* Balkema, Rotterdam, 1–468.
- Information on the Southern Basins of Libya study is available under www.casp.cam.ac.uk.

* *Guido Meinhold is Research Geologist at CASP, University of Cambridge; Daniel Paul Le Heron is Lecturer at the Department of Earth Sciences, Royal Holloway University of London.*

Society Business

Election – Fellows

The following names are put forward for election to Fellowship at the OGM on 24 November 2010.

ADAMS, Roy; ADDISON, Robert; AJDUKIEWICZ, Joanna Maria; ALLAMIN, Mohammed; ASKHAM, William John; BAKER, Martin Paul; BARDSLEY, Daniel Thomas; BAYLISS, Katherine Helen; BEAN, Stewart John; BERNAUS, Josep Maria; BIANCO, Daniel Simon; BIANCO, Lino (Angelo Emmanuel); BICKLEY, Matthew ; BLYTH, James Richard; BOGUE, Samuel Barrie; BUDD, David Andrew; BULMER, David Michael; BUSH, Thomas; CADMAN, Adam; CATLOW, Neil Kendrick; CATTERALL, David; CAULFIELD, Owen Robert; CHEUNG, Wah Funn; CHIU, Hon Chim; CHURCH, Lucy; CLARKSON, Euan Neilson Kerr; DANILOV, Vladimir Viktorovich; DAVIS, Oliver Thomas; DAY, Kevin Alan; DEJONG, Andreas; DUNKLEY JONES, Tom; EGDAR, Sarah Jane; EDGAR, Steven; EDWARDS, James; ELLIS, Richard; EMERSON, Christopher; FARRUGIA, Mark; FIELD, James; FITCH, Peter James Rowland; GARRETT, Lauren; GATES, Oliver James; GERRARD, Peter ; GLADWELL, David Robert; GRAHAM, David ; GRAHAM, David John; GRAHAM, David Ross; GRANT-WOOLLEY, Lawrence; GROOM, Simon Duncan; GROVE, Clayton; GWILLIAM, Charlotte Laura; HALE, Piers Justin; HAMANN, Martin Eric; HAMILTON, David James; HARRISON, Julian Richard Francis; HARTLEY, Laura Elizabeth; HAYWOOD, Sebastian Charles Jerome; HIGGS, David Michael; HOLROYD, Jonathan; HUGHES, Adam; HYDE, Matthew Charles; IDOGO, John; ILES, Andrew Richard; ISYAKU, Aminu Abdullahi; JAFFEY, Noah; JOHNSTON-ARMSTRONG, Paul; JOHNSTON, Pauline; JORDAN, Nina; JUSTICE (NEE BOOTH), Sophie Catherine; KANTIANA, Imade; KAZI, Iiyas; KARCZ, Zvi; KELLY, Grant; KIM, Oleg Vlasovich; KING, Adrian; KODJO-WAYO, Lina Korkor; KRAWCZYNSKI, Tomasz; LEE, Su-gon; LI, Chris Mei Har; LINNELL, Adam; LOUGH, Alastair Jason MacKenzie; LOVE, Jenny Victoria; LOWTHROPE, Sarah Louise; MARSDEN, Janette Frances; MASON, Peter Walton; MERRICK, Jonathan; MCLELLAN, Lesley; MILLAR, Stephen David; MOORE, Mark John; MORGAN, Stephen ; MORTON, Alex Edward; MYLES, James Peter; NEW, Tomothy Damion; NEWMAN, Miles; NORTON, Andrew David; OBIEGBU, Okechukuwu Livinus; OLUTUSIN, David Bamidele; PARRISH, Randall Richardson; PAQUAY, Richard Denis; PENTLAND, Timothy Simon; PHILPS, Barnaby; POSAMENTIER, Henry William; PRITCHARD, Stephen Edward; PRYER, Louise; PYKE, William James; RAINBOW, Richard Frederick; REID, Kevin; ROCHE, Ian Patrick; ROE, Elizabeth Victoria; ROWAN, Ann Victoria; SANGSTER, Heather; SCHRODER, Ivar Johannes; SEAL, Megan Parker; SEDDON, Richard; SELBY, Adam William; SHERRINGTON, Steven; SHIPTON, Zoe Kai; SHRESRHA, Rajendra; SIU, Tat Shing Stanley; SJOBLOM, Rolf Oscar Ingemar; SOMEFUN, Olayinka Olufemi; SOMMER, Nicholas A; SPENCE, Michael James; STAINES, Holly Kate; STOCKS, John; STRONG, Daniel James; SWALLOW, Elliot James; TATUM, Gregg James; TELLEFSEN, Jon Einar; THOMAS, Matthew James; TILLEY, Jason; TILLING, Miles Edward; TITTERON, Rosemary; TUCKER, Martin Gareth; UPTON, Kirsty Anne; VIERBUCHEN, Richard Carl; WALBY, Thomas Adrian; WARD, Robert Edward Thomas; WARRENDER, Ruth; WILKINSON, Kathryn Louise; WINMAN, Neil James; WOODS, Ashley Martin; WRIGHT, Iain James; YOUNGSON, Alisdair.

Future meetings

OGMs:
24 November 2010;
3 February 2011;
13 April 2011.

Council:
24 November 2010;
2/3 February 2011;
(residential);
13 April 2011.

Society Research Funds!

Applications for support from any of the Society funds (details on website) must be made on a special form, which can be downloaded from the Society Awards and Research Grants page at www.geolsoc.org.uk/grants. The form must be completed in full and accompanied by two letters of support from Fellows of the Society. Please send to the Awards Secretary at the Geological Society. In order to be considered at the next available committee meeting, applications and supporting documents should reach the Society no later than **4 February 2011**. The average award has been about £1000.

Honorary Fellows

Fellows are reminded that they may nominate candidates for Honorary Fellowship at any time. To find out how to do this, please go to www.geolsoc.org.uk/ honoraryfellowship. *EN*

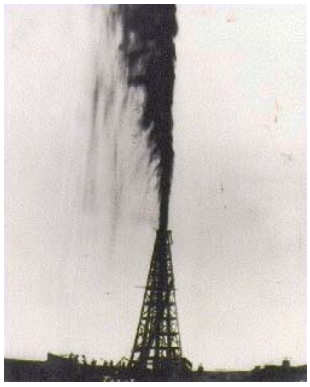
The Geological Society Club

The Geological Society Club, the successor to the body that gave birth to the Society in 1807, meets monthly (except over the field season!) at 6.30 for 7.00 in the Athenaeum Club, Pall Mall. Once a year there is also a special dinner at Burlington House. New diners are always welcome, especially from among younger Fellows. Dinner costs £45 for a four-course meal, including coffee and port. (The Founders' Dinner in November, has its own price structure.) There is a cash bar for the purchase of aperitifs and wine.

Please note – you should keep checking dates here as they may be subject to change without notice.

2011: 26 January; 23 February; 16 March; 13 April (Burlington House - prov.); 18 May

Any Fellow of the Society wishing to dine should contact Dr Andy Fleet, Secretary to the Geological Society Dining Club, Department of Mineralogy, The Natural History Museum, Cromwell Road, London SW7 5BD. Email: a.fleet@nhm.ac.uk - from whom further details may be obtained. *DR*



Shell London Lecture Series

Half empty or half full?

Just how much oil and gas can we recover from our fields, asks Robert Kleibergen…

In association with

Whether we like it or not, to meet the growing energy demand, the world will continue to rely for the next decades on oil and gas. Explorers may be able to find more accumulations in ever deeper and more remote locations, but it is equally important to increase the recovery of hydrocarbons from existing fields.

Robert Kleibergen has worked with Shell since 1987, and is currently Manager, Hydrocarbon Maturation in Shell International Exploration and Production.

Matinee: Tea and coffee 14.30; Lecture 15.00 – 16.00

Evening: Tea and coffee 17.30; Lecture 18.00 – 19.00

Further information

Please visit our website www.geolsoc.org.uk/shelllondonlectures10. Entry to each lecture is by ticket only. To obtain a ticket please contact Leila Taleb 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: Leila Taleb, Event Manager, The Geological Society, Burlington House, Piccadilly, London W1J 0BG, T: +44 (0) 20 7432 0981 E: leila.taleb@geolsoc.org.uk

Consultations

A responsive Society

*You can become involved in the Society's work to provide Earth science advice to government and Parliament, says Nic Bilham**

The Earth sciences have an essential role to play in addressing some of the great societal and economic challenges of the 21st Century. A key element of the 10-year strategy on which Council embarked in 2007 is to be more proactive in engaging with non-geologists, including policy makers, school-age students and interested members of the public.

One of the ways in which we can best help government and other policy-oriented bodies (and thus promote an understanding of the vital role of Earth sciences) is to provide high quality responses to consultations. These might relate to white papers being developed by government departments, inquiries by Parliamentary committees, or delivery plans brought forward by bodies charged with implementing policy. The Society is selective about the consultations to which it responds, in order to make sure that the energies of both its staff and Fellows are directed towards delivering high quality contributions in cases where there is a prospect of making a real difference.

In developing our responses, we are always keen to have the input from as many Fellows as possible with a range of perspectives on the issue at hand. However, the timescales for consultations is often short, and it is not usually possible, for example, to give notice of them in *Geoscientist*. We are therefore establishing a list of Fellows who would like to be informed when the Society intends to respond to a consultation. If you would like the opportunity to get involved in this important area of the Society's work, please email policy@geolsoc.org.uk. We will notify you by email when a consultation opens, and it is up to you whether or not to respond, depending whether the issue in question is of interest to you. Brief comments, or observations which to you seem obvious, can be just as helpful as thorough analyses! We will not usually contact the group more than once or twice a month.

The rich and varied expertise of our Fellowship is a unique resource. The more Fellows who are involved in putting together our responses, the greater their legitimacy will be in the eyes of the outside world. I do hope you will consider taking part.

** Head of Strategy and External Relations*

Society responds

The Society has responded (on 14 September) to the House of Commons Science and Technology Committee: Inquiry into Scientific Advice and Evidence in Emergencies. You can inspect the response at www.geolsoc.org.uk/consultations.

Chartership News

Why should I be Chartered?

Chartership Officer Bill Gaskarth answers some frequently asked questions about professional accreditation.

In some countries geology as a profession is regulated, very much as medicine and pharmacy are in the UK - where it is necessary to have a licence to practise. This is not yet so in the UK, though in some areas of employment professional qualifications are required (but not yet mandatory). CGeol is recognised throughout Europe as a professional qualification and is becoming recognised in many countries where the profession is regulated.

What professional titles are offered by the Geological Society?
Since 1990 the Society has offered the professional qualification of Chartered Geologist (CGeol) and has more recently been licensed to award the title of Chartered Scientist (CSci). Both designations require applicants to demonstrate their skills, experience and competence in their area of professional practice.

Which title is best suited to me and what I do?
For many Fellows, the nature of their work as practising geologists indicates clearly that the right path is to CGeol. To become chartered as a practising professional geologist you must be able to demonstrate in your application and at interview that you fulfil seven qualifying criteria by reference to the work that you do. Of these seven, two are unique to applicants for CGeol. In particular you must show that you understand the complexities of geology and geological processes in time and space in relation to your speciality, and that you are able to identify, collect, synthesise and evaluate geoscientific information to generate predictive models.

The Chartered Scientist qualification is equal in status to Chartered Geologist but does not require the proof of these two specialist criteria. All other criteria are the same and Chartership will be by reference to an area of professional practice in science. The increasing number of geology graduates employed in contaminated land specialisations and environmental science may well find that their work has taken them away from geology *per se*. They may not therefore be readily able to demonstrate through their work that they fulfil the two specialist geological criteria. These Fellows are geologists working as professional scientists in fields related to geology, where they have developed additional skills. It is for these Fellows in particular that the Society encourages validation as CSci.

Are there any other requirements for CSci?
The Science Council has a requirement that applicants either have a Master's (M) level qualification (MSc or MGeol or MSci etc) or can demonstrate working to this level through the quality of their supporting professional documents.

What if I am unsure which to apply for?
Contact the Chartership Officer, and discuss your situation with him and/or discuss this with your sponsors/line manager/mentor.

Can I apply for both at the same time?
Yes, but you will need to demonstrate how you satisfy the criteria for CGeol and for CSci in separate applications.

Can I apply for CGeol after gaining CSci?
Yes, should your employment change allowing more geological work, you can. But in your application and at interview you will need to produce supporting information to demonstrate how your geological expertise/competence fulfils the specialist geological CGeol criteria.

Can I apply for CSci retrospectively, following CGeol?
Yes. You will need to produce evidence of your CPD for the intervening period (up to two years) and demonstrate working/learning at Master's (M) level. This does not mean that

Open House 2010

The Society participated in 'Open House' for the first time this year

Georgina Worrall writes: 'Open House' is a London-wide celebration of buildings, places and neighbourhoods that are not normally open to the public, and allows everyone to get a glimpse inside premises they usually pass by. Hundreds of great buildings now open themselves up free, every year; and in 2010 an estimated quarter of a million people took advantage of the opportunity to get inside and have a good old nose around. For the first time, these inquisitive hordes included 400 visitors to the Society's apartments in Burlington House.

On Saturday 18 September, our guests were given conducted tours of the entrance hall, Council Room, and Upper and Lower Libraries. Bob Sandford (Julian Harrap Architects) was also available on the day to talk to visitors about the Bicentenary refurbishment works. Subject to staff availability at the weekend, we hope to be able to repeat the event next year.

you necessarily have an MSc (or MGeol, MSci etc) but that you can demonstrate, via your supporting documents, that the later ones show work at M level.

Does CGeol allow me to sign off reports in all areas of geology?
No. You are Chartered for the area of your competence. Should you move to working in other areas then you must gain competence there through being supervised and undertaking additional training.

Where can I get more information?
The GSL website, at www.geolsoc.org.uk/chartership, has all the up-to-date information you need. The CGeol and CSci application forms may be downloaded and there is guidance information for candidates, along with the Society Regulations governing each of these professional qualifications.

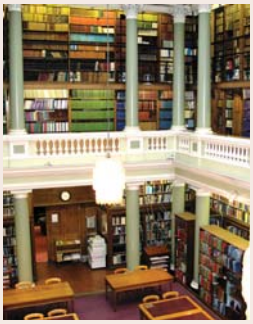
Can I get help and advice with my application?
Yes. First, attend meetings of your local Regional Group. As a Fellow you are automatically a member of one of these Regional Groups. There you will find many working professionals who will readily advise and help you. You may also contact the Chartership Officer to discuss any aspect of your application or with specific questions.

When do I become eligible to apply?
Eligibility requires that you have had a number of years' relevant post-graduation experience. A matrix showing the relationship between degrees and number of years' experience is available on the Society website. Should you need further information then you should contact the Chartership Officer at chartership@geolsoc.org.uk

- If you have a less frequently asked question, please contact chartership@geolsoc.org.uk.

CPD - a new system for a new year

David Manning (Professional Secretary) writes:
From the start of 2011, recording Continuing Professional Development (CPD) will be required for all those who complete the CGeol application process. Good habits have started, so let us keep them going! Of course, CPD is already compulsory for those of us who are CSci and EurGeol. In response to comments from Fellows we will be revising the website pages for online CPD recording, to make them more user-friendly. More details will be revealed in December's *Geoscientist*.



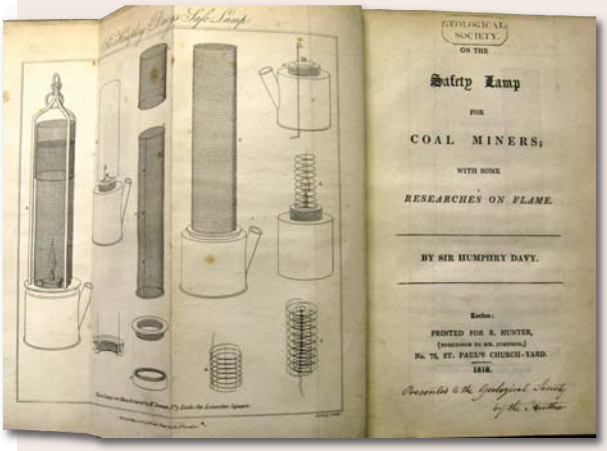
From the Library

The library is open to visitors

Monday-Friday 0930-1730.

For a list of **new acquisitions** click the appropriate link from **http://www.geolsoc.org.uk/gsl/info**

Rare book of the month



On the safety lamp for coal miners; with some researches on flame by Society founder Sir Humphry Davy. 1818

As the rescuers in Chile continue to drill towards the 33 stranded miners, locked two miles below the surface, we are reminded once again of what the July editorial of this magazine called our 'industrial heroes' – not only the men and women who daily risk their lives in pursuit of minerals for our commodity-driven world, but those called upon to improve and ensure their safety as they do so, and to perform mining miracles when things go wrong.

One such hero was Humphry Davy (1778–1829). Called upon to address the high numbers of explosions in mines, Davy found that the mixture of air and methane only reacted at a high temperature. A number of mining explosions had been caused by methane gas being ignited by the open flames of the lamps then used by miners. Davy devised a lamp with narrow tubes to cool down the gases, enclosing the flame in wire gauze. As historian David Knight states, the 'Davy lamp' was 'a device developed in the laboratory that worked down the mine—this was one of the very first examples of technology as applied science.'[1]

The Society's copy was presented by Davy himself to our then fledgling library, and is bound with his earlier essay, 'Practical hints on the application of wire-gauze to lamps, for preventing explosions in coal mines' (1816), in which he first presented his ideas to the Royal Institution. *Michael McKimm*

Reference

David Knight, 'Davy, Sir Humphry, baronet (1778–1829)', *Oxford Dictionary of National Biography*, online edn, Oxford University Press, Sept 2004

The Library operates a sponsorship scheme to help preserve and restore its rare books. For more information, contact Michael McKimm in the library, or see the Sponsor A Book page on the Society's website: www.geolsoc.org.uk/sponsorabook

New e-journals

Seven more e-journals are now available using 'Athens' logins. See the Virtual Library E-journals section www.geolsoc.org.uk/ejournals for details.

Stop pulling the carbon trigger

The Geological Society of London has published a statement about the geological evidence relating to past climates, atmospheric carbon levels, and their inter-relationship (for more information on the writing of the statement, see *Geonews*, p10).

Climate Change – a Statement by The Geological Society of London

Climate change is a defining issue for our time. The geological record contains abundant evidence of the ways in which Earth's climate has changed in the past. That evidence is highly relevant to understanding how it may change in the future. The Council of the Society is issuing this statement as part of the Society's work "to promote all forms of education, awareness and understanding of the Earth and their practical applications for the benefit of the public globally". The statement is intended for non-specialists and Fellows of the Society. It is based on analysis of geological evidence, and not on analysis of recent temperature or satellite data, or climate model projections. It contains references to support key statements, indicated by superscript numbers, and a reading list for those who wish to explore the subject further.

What is climate change, and how do geologists know about it?

The Earth's temperature and weather patterns change naturally over time scales ranging from decades, to hundreds of thousands, to millions of years[1]. The climate is the statistical average of the weather taken over a long period, typically 30 years. It is never static, but subject to constant disturbances, sometimes minor in nature and effect, but at other times much larger. In some cases these changes are gradual and in others abrupt.

Evidence for climate change is preserved in a wide range of geological settings, including marine and lake sediments, ice sheets, fossil corals, stalagmites and fossil tree rings. Advances in field observation, laboratory techniques and numerical modelling allow geoscientists to show, with increasing confidence, how and why climate has changed in the past. For example, cores drilled through the ice sheets yield a record of polar temperatures and atmospheric composition ranging back to 120,000 years in Greenland and 800,000 years in Antarctica. Oceanic sediments preserve a record reaching back tens of millions of years, and older sedimentary rocks extend the record to hundreds of millions of years. This vital baseline of knowledge about the past provides the context for estimating likely changes in the future.

What are the grounds for concern?

The last century has seen a rapidly growing global population and much more intensive use of resources, leading to greatly increased emissions of gases, such as carbon dioxide and methane, from the burning of fossil fuels (oil, gas and coal), and from agriculture, cement production and deforestation. Evidence from the geological record is consistent with the physics that shows that adding large amounts of carbon dioxide to the atmosphere warms the world and may lead to: higher sea levels and flooding of low-lying coasts; greatly changed patterns of rainfall[2]; increased acidity of the oceans [3,4,5,6]; and decreased oxygen levels in seawater[7,8,9].

There is now widespread concern that the Earth's climate will warm further, not only because of the lingering effects of the added carbon already in the system, but also because of further additions as human population continues to grow. Life on Earth has survived large climate changes in the past, but extinctions and major redistribution of species have been associated with many of them. When the human population was small and nomadic, a rise in sea level of a few metres would have had very little effect on *Homo sapiens*. With the current and growing global population, much of which is concentrated in coastal cities, such a rise in sea level would have a drastic effect on our complex society, especially if the climate were to change as suddenly as it has at times in the past. Equally, it seems likely that as warming continues some areas may experience less precipitation leading to drought. With both rising seas and increasing drought, pressure for human migration could result on a large scale.

When and how did today's climate become established?

The Earth's climate has been gradually cooling for most of the last 50 million years. At the beginning of that cooling (in the early Eocene), the global average temperature was about 6-7 ºC warmer than now[10,11]. About 34 million years ago, at the end of the Eocene, ice caps coalesced to form a continental ice sheet on Antarctica[12,13]. In the northern hemisphere, as global cooling continued, local ice caps and mountain glaciers gave way to large ice sheets around 2.6 million years ago[14].

Over the past 2.6 million years (the Pleistocene and Holocene), the Earth's climate has been on average cooler than today, and often much colder. That period is known as the 'Ice Age', a series of glacial episodes separated by short warm 'interglacial' periods that lasted between 10,000-30,000 years[15,16]. We are currently living through one of these interglacial periods. The present warm period (known as the Holocene) became established only 11,500 years ago, since when our climate has been relatively stable. Although we currently lack the large Northern Hemisphere ice sheets of the Pleistocene, there are of course still large ice sheets on Greenland and Antarctica[1].

What drives climate change?

The Sun warms the Earth, heating the tropics most and the poles least. Seasons come and go as the Earth orbits the Sun on its tilted axis. Many factors, interacting on a variety of time scales, drive climate change by altering the amount of the Sun's heat retained at the Earth's surface and the distribution of that heat around the planet. Over millions of years the continents move, ocean basins open and close, and mountains rise and fall. All of these changes affect the circulation of the oceans and of the atmosphere. Major volcanic eruptions eject gas and dust high into the atmosphere, causing temporary cooling. Changes in the abundance in the atmosphere of gases such as water vapour, carbon dioxide and methane affect climate through the Greenhouse Effect – described below.

As well as the long-term cooling trend, evidence from ice and sediment cores reveal cycles of climate change tens of thousands to hundreds of thousands of years long. These can be related to small but predictable changes in the Earth's orbit and in the tilt of the Earth's axis. Those predictable changes set the pace for the glacial-interglacial cycles of the ice age of the past 2.6 million years[17]. In addition, the heat emitted by the Sun varies with time. Most notably, the 11-year sunspot cycle causes the Earth to warm very slightly when there are more sunspots and cool very slightly when there are few. Complex patterns of atmospheric and oceanic circulation cause the El Niño events and related climatic oscillations on the scale of a few years[1,18].

What is the Greenhouse Effect?

The Greenhouse Effect arises because certain gases (the so-called greenhouse gases) in the atmosphere absorb the long wavelength infrared radiation emitted by the Earth's surface and re-radiate it, so warming the atmosphere. This natural effect keeps our atmosphere some 30ºC warmer than it would be without those gases. Increasing the concentration of such gases will increase the effect (i.e. warm the atmosphere more)[19].

What effect do natural cycles of climate change have on the planet?

Global sea level is very sensitive to changes in global temperatures. Ice sheets grow when the Earth cools and melt when it warms. Warming also heats the ocean, causing the water to expand and the sea level to rise. When ice sheets were at a maximum during the Pleistocene, world sea level fell to at least 120 m below where it stands today. Relatively small increases in global temperature in the past have led to sea level rises of several metres. During parts of the previous interglacial period, when polar temperatures reached 3-5°C above today's[20], global sea levels were higher than today's by around 4-9m[21]. Global patterns of rainfall during glacial times were very different from today.

Has sudden climate change occurred before?

Yes. About 55 million years ago, at the end of the Paleocene, there was a sudden warming event in which temperatures rose by about 6ºC globally and by 10-20ºC at the poles[22]. Carbon isotopic data show that this warming event (called by some the Paleocene-Eocene Thermal Maximum, or PETM) was accompanied by a major release of 1500-2000 billion tonnes or more of carbon into the ocean and atmosphere. This injection of carbon may have come mainly from the breakdown of methane hydrates beneath the deep sea floor[10], perhaps triggered by volcanic activity superimposed on an underlying gradual global warming trend that peaked some 50 million years ago in the early Eocene. CO_2 levels were already high at the time, but the additional CO_2 injected into the atmosphere and ocean made the ocean even warmer, less well oxygenated and more acidic, and was accompanied by the extinction of many species on the deep sea floor. Similar sudden warming events are known from the more distant past, for example at around 120 and 183 million years ago[23,24]. In all of these events it took the Earth's climate around 100,000 years or more to recover, showing that a CO_2 release of such magnitude may affect the Earth's climate for that length of time[25].

Are there more recent examples of rapid climate change?

Abrupt shifts in climate can occur over much shorter timescales. Greenland ice cores record that during the last glacial stage (100,000 – 11,500 years ago) the temperature there alternately warmed and cooled several times by more than 10ºC [26,27]. This was accompanied by major climate change around the northern hemisphere, felt particularly strongly in the North Atlantic region. Each warm and cold episode took just a few decades to develop and lasted for a few hundred years. The climate system in those glacial times was clearly unstable and liable to switch rapidly with little warning between two contrasting states. These changes were almost certainly caused by changes in the way the oceans transported heat between the hemispheres.

How did levels of CO_2 in the atmosphere change during the ice age?

The atmosphere of the past 800,000 years can be sampled from air bubbles trapped in Antarctic ice cores. The concentrations of CO_2 and other gases in these bubbles follow closely the pattern of rising and falling temperature between glacial and interglacial periods. For example CO_2 levels varied from an average of 180 ppm (parts per million) in glacial maxima to around 280 ppm during interglacials. During warmings from glacial to interglacial, temperature and CO_2 rose together for several thousand years, although the best estimate from the end of the last glacial is that the temperature probably started to rise a few centuries before the CO_2 showed any reaction. Palaeoclimatologists think that initial warming driven by changes in the Earth's orbit and axial tilt eventually caused CO_2 to be released from the warming ocean and thus, via positive feedback, to reinforce the temperature rise already in train[28]. Additional positive feedback reinforcing the temperature rise would have come from increased water vapour evaporated from the warmer ocean, water being another greenhouse gas, along with a decrease in sea ice, and eventually in the size of the northern hemisphere ice sheets, resulting in less reflection of solar energy back into space.

How has carbon dioxide (CO_2) in the atmosphere changed over the longer term?

Estimating past levels of CO_2 in the atmosphere for periods older than those sampled by ice cores is difficult and is the subject of continuing research. Most estimates agree that there was a significant decrease of CO_2 in the atmosphere from more than1000 ppm at 50 million years ago (during the Eocene) to the range recorded in the ice cores of the past 800,000 years[22]. This decrease in CO_2 was probably one of the main causes of the cooling that led to the formation of the great ice sheets on Antarctica[29]. Changes in ocean circulation around Antarctica may also have also played a role in the timing and extent of formation of those ice sheets[30,31,32].

How has carbon dioxide in the atmosphere changed in recent times?

Atmospheric CO_2 is currently at a level of 390 ppm. It has increased by one third in the last 200 years[33]. One half of that increase has happened in the last 30 years. This level and rate of increase are unprecedented when compared with the range of CO_2 in air bubbles locked in the ice cores (170-300 ppm). There is some evidence that the rate of increase in CO_2 in the atmosphere during the abrupt global warming 183 million years ago (Early Jurassic), and perhaps also 55 million years ago (the PETM), was broadly similar to today's rate[34].

When was CO_2 last at today's level, and what was the world like then?

The most recent estimates[35] suggest that at times between 5.2 and 2.6 million years ago (during the Pliocene), the carbon dioxide concentrations in the atmosphere reached between 330 and 400 ppm. During those periods, global temperatures were 2-3°C higher than now, and sea levels were higher than now by 10 – 25 metres, implying that global ice volume was much less than today[36]. There were large fluctuations in ice cover on Greenland and West Antarctica during the Pliocene, and during the warm intervals those areas were probably largely free of ice[37,38,39]. Some ice

may also have been lost from parts of East Antarctica during the warm intervals[40]. Coniferous forests replaced tundra in the high latitudes of the Northern Hemisphere[41], and the Arctic Ocean may have been seasonally free of sea-ice[42].

When global temperature changed, did the same change in temperature happen everywhere?

No. During the glacial periods in the Pleistocene the drop in temperature was much greater in polar regions than in the tropics. There is good evidence that the difference between polar and tropical temperatures in the warmer climate of the Eocene to Pliocene was smaller than it is today. The ice core record also shows differences between Greenland and Antarctica in the size and details of the temperature history in the two places, reflecting slow oceanic heat transport between the two poles[16].

In conclusion - what does the geological record tell us about the potential effect of continued emissions of CO_2?

Over at least the last 200 million years the fossil and sedimentary record shows that the Earth has undergone many fluctuations in climate, from warmer than the present climate to much colder, on many different timescales. Several warming events can be associated with increases in the 'greenhouse gas' CO_2. There is evidence for sudden major injections of carbon to the atmosphere occurring at 55, 120 and 183 million years ago, perhaps from the sudden breakdown of methane hydrates beneath the seabed. At those times the associated warming would have increased the evaporation of water vapour from the ocean, making CO_2 the trigger rather than the sole agent for change. During the Ice Age of the past two and a half million years or so, periodic warming of the Earth through changes in its position in relation to the sun also heated the oceans, releasing both CO_2 and water vapour, which amplified the ongoing warming into warm interglacial periods. That process was magnified by the melting of sea ice and land ice, darkening the Earth's surface and reducing the reflection of the sun's energy back into space.

While these past climatic changes can be related to geological events, it is not possible to relate the Earth's warming since 1970 to anything recognisable as having a geological cause (such as volcanic activity, continental displacement, or changes in the energy received from the sun)[43]. This recent warming is accompanied by an increase in CO_2 and a decrease in Arctic sea ice, both of which – based on physical theory and geological analogues - would be expected to warm the climate[44]. Various lines of evidence, reviewed by the Intergovernmental Panel on Climate Change clearly show that a large part of the modern increase in CO_2 is the result of burning fossil fuels, with some contribution from cement manufacture and some from deforestation[44]. In total, human activities have emitted over 500 billion tonnes of carbon (hence over 1850 billion tons of CO_2) to the atmosphere since around 1750, some 65% of that being from the burning of fossil fuels[18,45,46,47,48]. Some of the carbon input to the atmosphere comes from volcanoes[49,50], but carbon from that source is equivalent to only about 1% of what human activities add annually and is not contributing to a net increase.

In the coming centuries, continued emissions of carbon from burning oil, gas and coal at close to or higher than today's levels, and from related human activities, could increase the total to close to the amounts added during the 55 million year warming event – some 1500 to 2000 billion tonnes. Further contributions from 'natural' sources (wetlands, tundra, methane hydrates, etc.) may come as the Earth warms[22]. The geological evidence from the 55 million year event and from earlier warming episodes suggests that such an addition is likely to raise average global temperatures by at least 5-6°C, and possibly more, and that recovery of the Earth's climate in the absence of any mitigation measures could take 100,000 years or more. Numerical models of the climate system support such an interpretation[44]. In the light of the evidence presented here it is reasonable to conclude that emitting further large amounts of CO_2 into the atmosphere over time is likely to be unwise, uncomfortable though that fact may be.

[a] A background reading list is provided in the Online version of the statement.

References

1. Cronin, T.M., 2009, Paleoclimates: Understanding Climate Change Past and Present. Columbia University Press. ISBN: 978-0-231-14494-0, 441pp
2. Alverson, K.D., Bradley, R.S., and Pedersen, T.F., (eds.), 2003, Paleoclimate, Global Change and the Future. The IGBP Series. Springer-Verlag, New York. 221 pp.
3. Barker, S., and Elderfield, H., 2002, Foraminiferal calcification response to Glacial-Interglacial changes in atmospheric CO_2. Science 297. 833 – 83
4. Olafsson J., *et al.*, 2009, Rate of Iceland Sea acidification from time series measurements. Biogeoscience 6. 2661-2668
5. Caldeira, K. and Wickett, M.E. 2003, Anthropogenic carbon and ocean pH, Nature, 425. 365
6. Raven, J., *et al.*, 2005, Ocean acidification due to increasing atmospheric carbon dioxide. Policy document. The Royal Society: London
7. Whitney, F.A., H.J. Freeland, and M. Robert, 2007, Persistantly declining oxygen levels in the interior waters of the eastern subarctic Pacific. Progress in Oceanography 75 (2). 179-199.
8. Keeling, R.F., A. Kortzinger, and N. Gruber, 2010, Ocean Deoxygenation in a Warming World. Annual Review of Marine Science 2. 199-229.
9. Pearce, C.R., Cohen, A.S., Coe, A.L. and Burton, K.W., 2008, Molybdenum isotope evidence for global ocean anoxia coupled with perturbations to the carbon cycle during the Early Jurassic. Geology 3. 231-234.
10. Zachos, J.C., Pagani, M., Sloan, L., Thomas, E., and Billups, K., 2001, Trends, rhythms, and aberrations in global climate 65 Ma to present. Science 292. 686-693
11. Miller, K.G., Wright, J.D., and Browning, J.V., 2005, Visions of ice sheets in a greenhouse world. Marine Geology, 217, 215-231.
12. Barrett, P. J., 1996, Antarctic paleoenvironment through Cenozoic times—a review. Terr. Antart., 3. 103–119.
13. Cooper, A.K., and O'Brien, P.E., 2004. Leg 188 synthesis: transitions in the glacial history of the Prydz Bay region, East Antarctica, from ODP drilling. In Cooper, A.K., O'Brien, P.E., and Richter, C. (Eds.), Proc. ODP, Sci. Results, 188 [Online]. Available from http://www-odp.tamu.edu/publications /188_SR/synth/synth.htm.
14. Maslin, M.A., Li, X.S., Loutre, M.-F. and Berger, A., 1998, The contribution of orbital forcing to the progressive intensification of Northern Hemisphere glaciation. Quat. Sci. Rev. 17, 411–426.
15. Lisiecki, L.E. and Raymo, M.E., 2005. A Pliocene-Pleistocene stack of 57 globally distributed benthic delta O-18 records. Paleoceanography 20 (1), PA1003; doi:1010.1029/2004PA001071.
16. Jouzel, J., Masson-Delmotte, V., Cattani, O., Dreyfus, G., Falourd, S., Hoffmann, G., Nouet, J., Barnola, J.M., Chappellaz, J., Fischer, H., Gallet, J.C., Johnsen, S., Leuenberger, M., Loulergue, L., Luethi, D., Oerter, H., Parrenin, F., Raisbeck, G., Raynaud, D., Schwander, J., Spahni, R., Souchez, R., Selmo, E., Schilt, A., Steffensen, J.P., Stenni, B., Stauffer, B., Stocker, T., Tison, J.-L., Werner, M. and Wolff, E.W., 2007. Orbital and millennial Antarctic climate variability over the last 800 000 years. Science 317, 793-796.

17. Imbrie, J. and Imbrie, K.P. 1979. Ice Ages: Solving the Mystery. MacMillan, London. 224pp
18. Houghton, J., 2009, Global Warming: The Complete Briefing. 4th edition. Cambridge University Press, 438pp
19. Walker, J.C.G., P.B. Hays, and J.F. Kasting, 1981, A Negative Feedback Mechanism for the Long-Term Stabilization of Earths Surface-Temperature. Journal of Geophysical Research - Oceans and Atmospheres 86. 9776-9782
20. Otto-Bliesner, B.L., Marshall, S.J., Overpeck, J.T, Miller, G.H., Hu, A., and CAPE Last Interglacial Project members, 2006, Simulating Arctic Climate Warmth and Icefield Retreat in the Last Interglaciation. Science 311, 1751-1753
21. Kopp, R.E., Simons, F.J., Mitrovica, J.X., Maloof, A.C. and Oppenheimer, M., 2009. Probabilistic assessment of sea level during the last interglacial stage. Nature, 462, 863-867, doi:10.1038/nature08686.
22. Zachos, J.C., Dickens, G.R., and Zeebe, R.E., 2008, An early Cenozoic perspective on greenhouse warming and carbon-cycle dynamics. Nature, 451: p. 279-283.
23. Kemp, D.B., *et al.*, 2005, Astronomical pacing of methane release in the Early Jurassic period. Nature 437. 396-399.
24. Jenkyns, H.C., 2010, Geochemistry of oceanic anoxic events. Geochem. Geophys. Geosyst., 11(3): p. Q03004.
25. Archer, D., *et al.*, 2009, Atmospheric Lifetime of Fossil Fuel Carbon Dioxide. Annual Review of Earth and Planetary Sciences 37. 117-134.
26. Blunier, T. and Brook, E.J., 2001. Timing of millennial-scale climate change in Antarctica and Greenland during the last glacial period. Science 291 (5501), 109-112.
27. Johnsen, S.J., Clausen, H.B., Dansgaard, W., Fuhrer, K., Gundestrup, N., Hammer, C.U., Iversen, P., Jouzel, J., Stauffer, B. and Steffensen, J.P., 1992. Irregular glacial interstadials recorded in a new Greenland ice core. Nature 359, 311-313.
28. Lüthi, D., Le Floch, M., Stocker, T.F., Bereiter, B., Blunier, T., Barnola, J.M., Siegenthaler, U., Raynaud, D. and Jouzel, J., 2008. High-resolution carbon dioxide concentration record 650,000-800,000 years before present. Nature 453, 379-382.
29. DeConto, R.M. and Pollard, D., 2003, Rapid Cenozoic glaciation of Antarctica induced by declining atmospheric CO_2, Nature, 421, 245–249.
30. Livermore, R.A., Hillenbrand, C.-D., Meredith, M. and Eagles, G., 2007, Drake Passage and Cenozoic climate: An open and shut case? Geochemistry, Geophysics, Geosystems, 8(1), Q01005, doi:10.1029/2005GC001224
31. Huber, M., Brinkhuis, H., Stickley, C.E., Doos, K., Sluijs, A., Warnaar, J., Schellenberg, S.A., and Williams, G.L., 2004, Eocene circulation of the Southern Ocean: was Antarctica kept warm by subtropical waters? Paleoceanography 19(4), PA3026, doi:10.1029/2004PA001014
32. Francis, J.E., Marenssi, S., Levy, R., Hambrye, M., Thorn, V.C., Mohr, B., Brinkhuis, H., Warnaar, J., Zachos, J., Bohaty, S., and DeConto, R., 2009, From Greenhouse to Icehouse – the Eocene/Oligocene in Antarctica. Florindo, F., and Siegert, M., (eds.), Antarctic Climate Evolution, Chapter 8, Developments in Earth and Environmental Sciences 8., Elsevier, 209-368
33. MacFarling Meure, C., Etheridge, D., Trudinger, C., Steele, P., Langenfelds, R., van Ommen, T., Smith, A. and Elkins, J., 2006. Law Dome CO_2, CH_4 and N_2O ice core records extended to 2000 years BP. Geophysical Research Letters 33 (14), L14810, doi:14810.11029/12006GL026152.
34. Cohen, A.S., Coe, A.L. and Kemp, D.B., 2007, The Late Palaeocene Early Eocene and Toarcian (Early Jurassic) carbon isotope excursions: a comparison of their time scales, associated environmental changes, causes and consequences. Journal of the Geological Society, 164: 1093-1108.
35. Seki, O., Foster G.L., Schmidt, D.N., Mackensen, A., Kawamura, K., and Pancost, R.D., 2010, Alkenone and boron-based Pliocene pCO_2 records. Earth and Planetary Science Letters Volume 292, Issues 1-2, 201-211
36. Dowsett, H.J. and Cronin, T.M. 1990. High eustatic sea level during the Middle Pliocene: Evidence from the southeastern U.S. Atlantic Coastal Plain. Geology 18. 435-438.
37. Naish, T. and 55 others, 2009, Obliquity-paced Pliocene West Antarctic ice sheet oscillations. Nature 458. 322-328.
38. Lunt, D.J., Foster, G.L., Haywood, A.M., Stone, E.J., 2008, Late Pliocene Greenland glaciation controlled by a decline in atmospheric CO_2 levels, Nature, 454(7208), pp1102-5. doi:10.1038/nature07223
39. Pollard, D., and DeConto, R.M., 2009, Modelling West Antarctic ice sheet growth and collapse through the past five million years. Nature, 458, 329-332.
40. Hill, D.J., Haywood, A.M., Hindmarsh, R.C.A., Valdes, P.J., 2007, Characterising ice sheets during the mid Pliocene: evidence from data and models, In: Williams, M., Haywood, A.M., Gregory, J., and Schmidt, D., (eds.), Deep-time perspectives on climate change: marrying the signal from computer models and biological proxies. The Micropalaeontological Society, Special Publication, The Geological Society, London, 517-538.
41. Salzmann, U., Haywood, A.M., Lunt, D.J., Valdes, P.J., and Hill, D.J., 2008, A new global biome reconstruction and data-model comparison for the Middle Pliocene, Global Ecol. Biogeogr., 17(3), 432-447. doi:10.1111/j.1466-8238.2008.00381.x
42. Cronin, T.M., Whatley, R.C., Wood, A., Tsukagoshi, A., Ikeya, N., Brouwers, E.M. and Briggs, W.M. 1993. Microfaunal evidence for elevated mid-Pliocene temperatures in the Arctic Ocean. Paleoceanography 8, 161-173.
43. Bard, E., and Delaygue, G., 2008, Comment on "Are there connections between the Earth's magnetic field and climate?" by V. Courtillot, Y. Gallet, J.-L. Le Mouël, F. Fluteau, A. Genevey EPSL 253, 328, 2007; Earth & Plan. Sci. Letts., vol. 265, No 1-2, 302-307
44. Solomon, S., Qin, D., and Manning, M., *et al.*, 2007, Climate change 2007: The physical science basis. Contribution of Working Group I to the 4th Assessment Report of the IPCC. CUP, Cambridge, 996pp
45. Andres, R.J., Marland, G., Boden, T., and Bischoff, S., 2000, Carbon dioxide emissions from fossil fuel consumption and cement manufacture, 1751-1991, and an estimate of their isotopic composition and latitudinal distribution. In Wigley, T.M.L., and Schimel., D.S., eds. The Carbon Cycle. Camb. Uni. Press., 53-62
46. World Resources Institute 2010, Climate Analysis Indicators Tool (CAIT): http://cait.wri.org/.
47. Metz, B., Davidson, O., *et al.*, 2007, Climate Change 2007 – Mitigation of Climate Change. Contribution of Working Group III to the 4th Assessment of the IPCC. CUP, Cambridge, 851pp
48. Carbon Dioxide Information Analysis Centre of the US Department of Energy - http://cdiac.ornl.gov/.
49. Williams, S.N., Schaeffer, S.J., Calvache, M.L., and Lopez, D., 1992, Global carbon dioxide emissions to the atmosphere by volcanoes. Geochim. Cosmochim. Acta 56, 1765-1770.
50. Marty, B., and Tolstikhin, I.N., 1998, CO_2 fluxes from mid-ocean ridges, arcs and plumes. Chem. Geol. 145, 233-248.

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Mt Everest from base camp by Martin Lack

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•**2-4 November** *MineSched Development & Production Workshop* **Venue**: Coalville. The MineSched Development & Production Workshop is a comprehensive three-day workshop, amalgamating both the Development and Production Workshops into one. Contact Gemcom: T: +44 1530 835554 E: sales-eu@gemcomsoftware.com. W: www.gemcomsoftware.com

•**10 November** *Groundwater Levels and Datalogger Workshop - Accuracy and Good Field Practice.* **Venue:** Birmingham. The requirements of the Water Framework Directive have given a new emphasis to the need for groundwater level monitoring, and for obtaining reliable data. Register: Contact: Julie Rose T: 0121 733 3533 E: Julie.rose@waterrauk.com W: www.waterrauk.com/Pages/general/training.asp

•**17 November** *Geodiversity & Geoconservation - An introduction for non-specialist audiences.* Venue: Liverpool Hope University. Course Fee: £160 (a 10% reduction is applicable for Geological Society and GeoConservationUK & RIGS group members). Contact: Dr Kevin Crawford. E: crawfok@hope.ac.uk W: http://wiki.geoconservationuk.org.uk

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NOVEMBER

•**2-4 November.** *3rd International Workshop on Criminal and Environmental Soil Forensics. " The Dirty Evidence - Soil and Geoscientific Contributions to Intelligence Gathering and Environmental and Public Safety".* Venue: Long Beach California. Join us for this unique blend of soil experts and forensic geoscience experts from around the world! **Contact**: Marianne Stam E: marianne.stam@doj.ca.gov

•**2-3 November.** *Past Carbon Isotopic Events and Future Ecologies - Palaeoanalogue CIEs and current biosphere & ecological change as guides to the 22nd Century and beyond.* This two-day discussion meeting sees invited presentations from internationally renowned geoscientists and ecologists in environmental and palaeoenvironmental change. **Contact**: Georgina Worrall: T: 020 7434 9944 F: 020 7494 0579 E: georgina.worrall@geolsoc.org.uk

North West Regional

•**4 November.** *Coal Bed Methane Extraction - Warrington and the Wirral* Venue: The Centre Lecture Theatre, Birchwood Park, Warrington at 1830. Brent Cheshire and Dr Lloyd Boardman of IGas Energy present a talk on Coal Bed Methane Extraction in Warrington & the Wirral. **Contact**: Gillian Hurworth T: 0161 4996836 E: gillian_hurworth@coffey.com

•**4-5 November**. Advances in Carbonate Exploration and Reservoir Analysis. Venue: Burlington House. Middle East, Emerging Plays and Concepts, Advances in Outcrop Studies, Faults/Fractures, Karst and Interaction with Sequence Stratigraphy, Carbonate Reservoirs in Rift Settings, Impact on Reservoir Quality of Fracture Diagenesis and Burial Karst, Hydrothermal Dolomitisation, Porosity Classification and Evolution, and Geomodelling Challenges in Carbonates. **Contact**: Steve Whalley: T: 020 7432 0980 F: 020 7494 0579 E: steve.whalley@geolsoc.org.uk.

•**5 November**. *Northern North Sea: Recent Developments in Exploration and Production.* Workshop. Venue: Kings College Conference Centre, University of Aberdeen. To provide a forum for the exchange of ideas arising from recent experiences of exploration, development and production activities in the Northern North Sea. **Contact**: Steve Whalley: T: 020 7432 0980 F: 020 7494 0579 E: steve.whalley@geolsoc.org.uk.

South East Regional

•**9 November.** *Engineering Geology in Kent.* Venue: Bell Inn, Godstone. 1800 for 1830. Speaker – Keith Gabriel. **Contact:** Ron Williams T: 01737 553740 E: rew182@btinternet.com

West Midlands Regional

•**9 November.** *Severn Valley Railway Landslides and Flood Damage 2007 - Investigation, Design and Repair* Venue: Wolverhampton University, Room MC001, School of Applied Sciences, Wulfruna St, Wolverhampton. 1830. Speaker: Julian Hughes (GIP Ltd). **Contact:** Adrian Jones E: adrian.a.jones@uk.mwhglobal.com

Western Regional

•**9 November**. *Challenges in Investigating Mineral Resources - at La Granja Copper Project, Peru.* Venue: S H Reynolds Lecture Theatre (Room G25), Department of Earth Sciences, University of Bristol, Wills Memorial Building, Queen's Road, Bristol, 1800 for 1830. Speaker: Mark Howson, Rio Tinto. La Granja is probably the largest known unexploited copper deposit in South America. **Contact**: Toby Hopkins E: toby.hopkins@magnoxsouthsites.com

Southern Wales Regional

•**10 November.** *Langbaugh Quarry - The Impact of Dolerite Mining in the Cleveland Dyke on Present Day Land Use* Venue: Lecture Theatre 1.25, School of Earth and Ocean Sciences, Cardiff University CF10 3AT, 1730 for 1800. The talk will outline the history and development of mining at the site, how the legacy might impact present day land-use and how impacts have been addressed. **Contact:** Dave Jones T: +44 (0)29 2046 6096 E: david.jones@environment-agency.gov.uk

•**10 November**. *Half Empty or Half Full - How much oil and gas can we recover from our fields?* A Shell London Lecture. Venue: Burlington House at 1430 for 1500 and 1730 for 1800. **Contact:** Leila Taleb T: 020 7432 0981 F: 020 7494 0579 E: leila.taleb@geolsoc.org.uk

•**11 November**. *Founders' Day Lecture & Dinner. From Paviland to Pakefield: 700,000 years of Homo Britannicus* Venue: Burlington House & Le Meridien. Speaker: Chris Stringer (Natural History Museum, London). Price: £70. Black Tie. After dinner speaker – Prof. Dick Selley. **Contact:** Georgina Worrall T: 020 7432 0983 F: 020 7494 0579 E: georgina.worrall@geolsoc.org.uk

HOGG

•**16-17 November**. *History of Applied Geology.* Venue: Burlington House. The practice and application of geological methods and skills probably predate geology as a written or pure science. **Contact:** Prof Richard Moody E: rtj.moody@virgin.net

Central Scotland Regional

•**16 November**. *AGM and Cononish Gold Mine.* Venue Edinburgh, TBC., 1815. Speaker: Chris Sangster. **Contact:** Julie Parsons: Donaldson Associates Ltd., The Pentagon Centre, Washington Street, Glasgow G3 8AZ

South West Regional

•**17 November.** *AGM.* Venue: Ley Arms, Kenn nr Exeter, 1830 for 1900. In addition to our AGM business, the Frederick Sherrell Award for Career Recognition will be presented to Brian Leveridge, formerly of the British Geological Survey (Exeter Office). **Contact:** Cathy Smith E: swrg@geolsoc.org.uk

Southern Wales Regional

•**25 November.** *Geological Society & ICE Ground Engineering Group Social Dinner* The dinner will be at the Park Plaza Hotel in Cardiff at 1900. Tickets are £30 for Fellows of the Geological Society/members of the GEG, £35 for non-fellows/members. Includes a three-course meal, wine, teas & coffees and after-dinner talk from Dr Laurance Donnelly (Wardell Armstrong) on Forensic Geology. **Contact:** Dave Jones T: +44(0)29 2046 6096 F: +44(0)29 2046 6070 E: david.jones@environment-agency.gov.uk.

North West Regional

•**25 November**. *Discovery of the Reko Diq Porphyry Copper - Gold System in Pakistan* Venue: Williamson Lecture Theatre, University of Manchester, 1830. Speaker: Tim Livesey - Director, Drilling Support & Technology; Exploration Manager (Eurasia) Barrick Gold. **Contact:** Chris Berryman E: chrisberryman@terraconsult.co.uk.

•**29 November**. *Polar Bears, Politics and Petroleum.* Venue: Burlington House, Evening. Introduced by Dr Robert Scott of CASP. Three presentations offer differing perspectives on the Arctic region as a potential source of hydrocarbon resources. Registration fee £25 Fellows, £35 non-Fellows. **Contact:** Steve Whalley: +44 (0)20 7432 0980 E: steve.whalley@geolsoc.org.uk.

Petroleum Group Committee Nominations 2011

Nominations for the Petroleum Group Committee are now open

The Petroleum Group is dedicated to petroleum exploration and production with a mandate to advance the study and understanding of petroleum geology, through conferences, workshops, publications and the encouragement of research. The committee also represents the Society in respect of petroleum geological issues. The Committee draws on participants from both industry and academia and is heavily involved in promoting Petroleum Geoscience throughout the UK and internationally.

If you would like to join the committee or know someone who you feel would like to make a contribution to the promotion and advancement of Petroleum Geoscience in the UK further information on the role of the Committee as well as the nomination forms can be found on the Petroleum Group web pages. Nominations must be received by **Friday 19 November 2010**

Nominations will be voted for by the general membership of the Group and successful candidates will be contacted in the New Year.

For further details please visit the Petroleum Group web pages: www.geolsoc.org.uk/petroleum or contact Steve Whalley by phone: +44 (0)20 7432 0980, or email: steve.whalley@geolsoc.org.uk

PETROLEUM GROUP

At the forefront of petroleum geoscience
www.geolsoc.org.uk/petroleum

Petroleum Group Silver Medal & Young Explorer Award Nominations

Nominations for the Petroleum Group's annual awards are now open.

Silver Medal Award

The Petroleum Group Silver Medal is a yearly award presented to individuals with a geoscience background who have made outstanding contributions to the petroleum industry. It can be awarded for excellence in petroleum geoscience and/or management of oil-finding activities. The winner will be presented with the medal at the Petroleum Group Annual Dinner on 16th June 2011.

Young Explorer Award

To recognise young talent, the future of our industry, the Petroleum Group will be awarding the medal at their 2010 Annual Dinner. Nominees should be under 35 and have made a significant contribution to the discovery of hydrocarbons or an emerging talent who is making a significant impact in production. The winner will be presented with the medal at the Petroleum Group Annual Dinner on the 16th June 2010. Unsuccessful nominees will be mentioned in the Chair's speech at the Annual Dinner and will also be mentioned in the Petroleum Group E-Newsletter.

For further details please visit the Petroleum Group web pages: www.geolsoc.org.uk/petroleum or contact Steve Whalley by phone: +44 (0)20 7432 0980, or email: steve.whalley@geolsoc.org.uk

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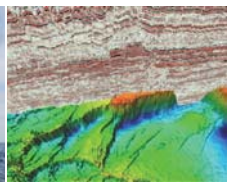
SPE International Society of Petroleum Engineers

The Geological Society

Northern North Sea: Recent Developments in Exploration and Production

Friday 5 November 2010

Kings College Conference Centre, University of Aberdeen



Convenors:

Jaquie Bond (ExxonMobil)
Jamel Ouzzane (BP)
Chris Jackson (Imperial College)
Eirik Larsen (Rocksource ASA)
Tom Dreyer (Statoil)
Fazrie Wahid (Schlumberger)
Haakon Dahle Smith (Chevron)
Rhod Phillips (Fairfield Energy)

REGISTRATION NOW OPEN

The Northern North Sea still provides fresh opportunities for exploration, development and production. In common with other mature provinces it has seen an influx of smaller independent operators filling the vacuum left in the wake of departing majors from aging assets. The industry has targeted new play concepts leading to exploration successes eg (Rinnes Discovery) whilst embracing the challenge of developing unconventional accumulations (eg heavy oil) and extending the life of mature assets. Demand for continual improvement in oil recovery has required ongoing technological innovation to meet production challenges and maximize field value.

Following on from the successful workshops held on the Southern Gas Basin (2007) and Central North Sea (2008), the purpose of this one day joint SPE/Geological Society seminar is to provide a forum for the exchange of ideas arising from recent experiences of exploration, development and production activities in the Northern North Sea.

For further information about this conference, please contact:
Steve Whalley, Event Co-ordinator: +44 (0)20 7432 0980
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The Geological Society

Polar Bears, Politics and Petroleum

Conflicting Issues in Arctic Hydrocarbon Exploration

29 November 2010, 6.00 – 8.30pm

The Geological Society, Burlington House, Piccadilly, London

equipoise

Convenors:

Dr Robert Scott (CASP)
Duncan Wade (ERC Equipoise)

REGISTRATION NOW OPEN

Following an introduction from Dr Robert Scott of CASP, three presentations will offer differing perspectives on the increasing interest in the Arctic region as a potential source of hydrocarbon resources. These will include an overview of the petroleum potential, the environmental issues associated with hydrocarbon exploration and the potential political conflicts in the region.

Speakers

Arne Rosenkrands - DONG Energy and Chair of Greenland Oil Industry Association
Dr Paul Berkman - Scott Polar Research Institute
Prof Alan Rodger - British Antarctic Survey

The lecture will be followed by a question and answer session and refreshments in the Lower Library at Burlington House.

Nominal registration fee of £25 fellows and £35 non fellows.

For further information and registration, please contact:
Steve Whalley, Event Co-ordinator: +44 (0)20 7432 0980
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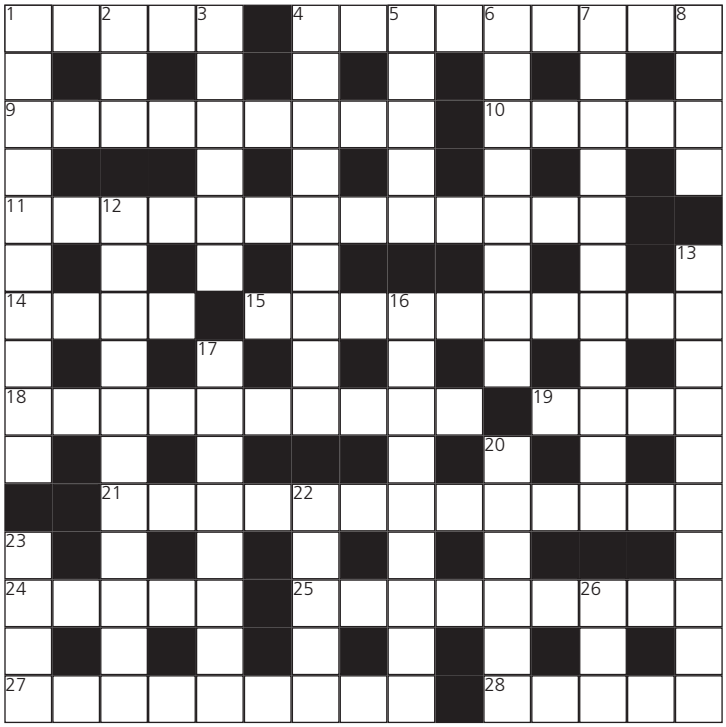
Crossword no. 141 set by Platypus



Solutions: August

Across: **1** Dykes **4** Tubercles **9** Neptunian **10** Blush **11** Drilling FLuid **14** Trim **15** Disorderly **18** Overcoming **19** Eton **21** Cartographers **24** Monet **25** Inherence **27** Oversleep **28** Epsom

Down: **1** Denudation **2** Kip **3** Squall **4** Triennium **5** Banff **6** Rebounds **7** Launderette **8** Soho **12** Iridescence **13** Gymnosperm **16** Ownership **17** Accretes **20** Spurge **22** Oxide **23** Ammo **26** Nos

Win a Special Publication of your choice!

The winner of the September Crossword prize draw was Paul Board of Old Colwyn, North Wales.

All correct solutions will be placed in the draw, and the winner's name printed in the February issue. The Editor's decision is final and no correspondence will be entered into. Closing date – December 14.

The competition is only 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 enter by scanning the signed form and emailing it as a PDF to ted.nield@geolsoc.org.uk.

Name .....

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Across

1 Blooming auturophic uni to multicellular organisms! (4)
4 Golden pound (9)
9 Deceptive appearance of Dr Gabor (9)
10 The piece of Middle Eastern Council Chamber furniture we all have in our homes (5)
11 Chaotic continental slope deposits formed by giant submarine landslides (14)
14 Nervous prolongation (4)
15 Reducing in volume, like a deposit far from a source of sediment (10)
18 Male and female reproductive cells of equal size (10)
19 A plague on your eagle owl (4)
21 Catalogue of medicinal substances (13)
24 What you need most on the night of the murder (5)
25 Most full of opaline silica nodules (9)
27 Mineral deposits between grains are doing this (9)
28 Afflicted by acariasis (5)

Down

1 Lacking in the usual annoying aberrations (10)
2 Not exactly solid, but not liquid either (3)
3 Played without silent spaces, Italianately (6)
4 Steatite, commonly (9)
5 Protective eye-screen (5)
6 Basic element of knowledge (8)
7 Installation of an incumbent in office (11)
8 Brides of Christ (4)
12 The property of being closely similar in shape, crystallographically (11)
13 Behaving without sign of education or refinement (10)
16 Flushing with large amounts of water (9)
17 Relating to the famous oolite banks off Florida (8)
20 Mucus, phlegm and saliva (6)
22 Sunni scholar who expounds Sharia Law (presumably in everyday dress) (5)
23 Friedrich Mohs's number one for armpits (4)
26 Longest time (3)

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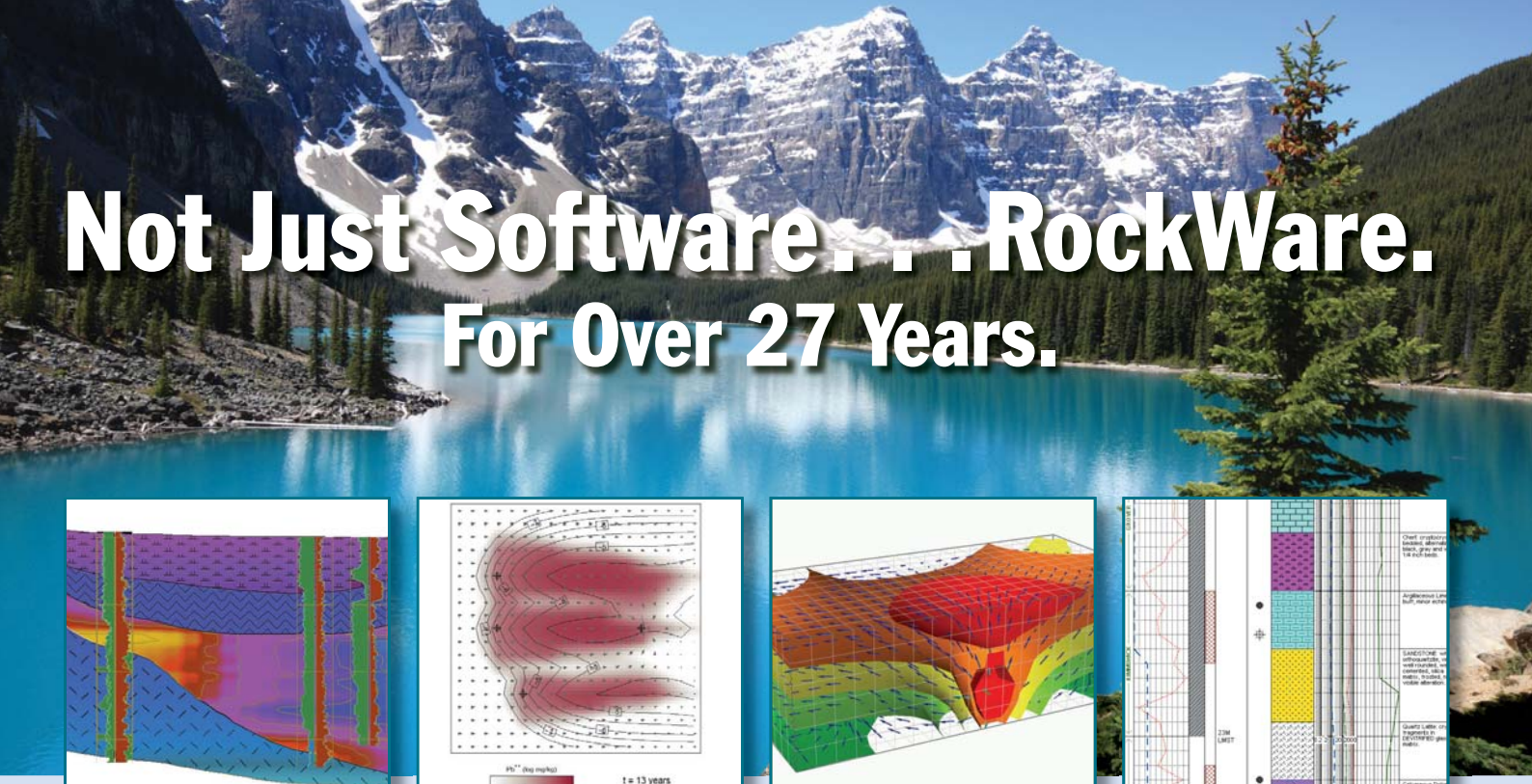

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