

Geoscientist

Volume 20 • No 8 • August 2010

- Arctic Russia's georesources
- A new "Burgess Shale"
- Should we scrap the Tertiary?



Science and democracy

Ted Nield has a feeling that scientific questions cannot be decided by a show of hands.

Of all fields of human endeavour, science is the most equitable because, with application and a modicum of intelligence, anyone can make a valid contribution to it. Science is a collective endeavour, made up of the myriad small accretions of knowledge from large swarms of workers, each of whom makes his or her contribution to the great edifice, knowing that subsequent generations' achievements will rest on them for ever. Thus, even a mediocre scientist, which by Gaussian distribution means the majority, can do work for which future generations will be thankful. The arts, by contrast, are cruel and hugely wasteful, like nature herself. What room in the long term, is there for a third-rate poet? In the arts there is no posterity in being average.

That said, not all scientists are equally able. The truly great are transcendent and change the design of the anthill that future scientists will build. After them, nothing is quite the same; and they all have a hell of a time persuading the rest. For, as computer pioneer Howard Aiken (1900-73) famously said: "Don't worry about people stealing your ideas. If your ideas are any good, you'll have to ram them down people's throats".

Science is a human endeavour in which the herd instinct – descending occasionally into gang culture – is strong. Most scientists prefer a quiet life and don't like the furniture being moved too often. Those who pay scant attention to history often find themselves denying a revolutionary idea because "how can so many people have been so wrong for so long?". No doubt adherents of phlogiston theory felt this way about Lavoisier. The number of people who believe something has no bearing upon its rightness.

Northern Ireland's born-again minister of culture Nelson McCausland, writing to the Ulster Museum's Trustees, recently urged them to reflect creationist and "intelligent design" theories in exhibitions, claiming that its inclusion constituted a "human rights issue". Mr McCausland, who is also said to believe that Ulster Protestants are a lost tribe of Israel, claims that one third of that tribe believes that the Earth was created about 6000 years ago. For that reason, he said, the Museum should reflect "the views, beliefs and cultural traditions that make up society in Northern Ireland".

Well, no, minister. Being scientifically "right" is not decided democratically, and some knowledge is science, and some is not. And that which is not has no place in a public museum (of anything other than ethnography) no matter how many people believe it.

Dr Tony Bazley, Editor, *Earth Science Ireland*, said: "The community in Ireland that I know would profoundly disagree that creationist views should be given significant space in publicly funded museums, visitor centres, school science lessons or science textbooks."

Conall McDevitt MLA represents the constituency that includes the Ulster Museum. In his former life (as a consultant with Weber Shandwick) he assisted with the Society's Bicentenary in 2007. He told *Geoscientist* that he was "shocked and saddened by the Minister's comments. They betray a prejudice and ignorance which is entirely unreflective of this region."

Amen, says this magazine, to that. 



Front cover: A marrellomorph arthropod from the Fezouata biota, a 'Burgess Shale-type' fauna, rich in fossils of soft-bodied creatures, recently found in the Lower and Upper Fezouata formations of Morocco, 480-472 Ma (Early Ordovician) and providing a link between Burgess Shale communities of the Middle Cambrian and the Great Ordovician Biodiversification Event.

Photo: P. Van Roy. See p.14.



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Top of the pops?

As academics obsess over how citations are used to measure performance, Rob Butler wonders whether they should borrow an idea from the music industry...

Metrics hysteria is creeping over UK universities as we gear up for the Research Excellence Framework. Publication records are the basis for appointments and promotion the world over. So there are new ways of designating which papers are important, moving from simple citations to adding Journal Impact Factors, and now valuing researchers by their so-called "H-index". But what might we learn from other communities that obsess over individual performance and the impact of their products?

In September 2004, just as Journal Impact Factors were launched, Westlife's *Flying Without Wings* reached Number 1. It may be a particularly forgettable boy-band ballad, but the song is important. It was the first to top the UK's official singles chart on downloads. It wasn't about "citations". The music chart is not constructed from the number of times a song is mentioned in the music press or performed by a tribute band. As you listen on a Sunday afternoon to Radio 1's chart show, you get a direct measure of a particular type of impact - sales. If people value the music they buy it. And mostly these days they do so by download.

Similarly, we increasingly download papers direct from publishers - either as a pdf, or by reading the full html version online. Download statistics track buyers. Surely these are a better measure of value than citations? I therefore thought it might be interesting to see how well citations track downloads for some of my own output. I took nine papers published in the *Journal of the Geological Society* between 1987 and 2008 and, with the help of the Publishing House, got the download statistics for a 30-month period. The comparison with citations is stark. According to *Web of Science*, the nine papers were cited 229 times, of which 37 accrued in the past 30 months. Their total number of downloads (html and pdf) for the same period was 4284. Even

assuming authors read the papers they cite, the citations only represent about five percent of the demand for my research - or less than 1% in the 30 months. I suspect this imbalance is not unusual - and there is no correlation between my personal download chart and the citation record. So perhaps citations are poor measures of utility or value.

Now, I'm not arguing for weekly download hit-parades, but there may be advantages in the approach. Authors could choose to publish in journals that actively promote online access, just as successful artists can select better labels. This could improve online access for all, and would allow us to demonstrate that our work isn't being read solely by a small cabal of the like-minded. If papers are used for teaching, industrial application, or to inform government, they will be downloaded - even though they may not be cited.

If you agree, vote now to get Simon Cowell onto the REF panel. I look forward to seeing the first "novelty" papers appearing for next Christmas. Or the dance remix of "Thrust Sequences"...

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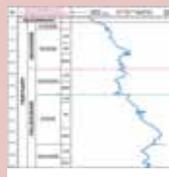
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Win a special publication of your choice

Soapbox - is open to contributions from all Fellows. You can always write a letter to the Editor, of course; but perhaps you feel you need more space? If you can write it entertainingly in 500 words, the Editor would like to hear from you. Email your piece, and a self-portrait, to ted.nield@geolsoc.org.uk. Copy can only be accepted electronically. No diagrams, tables or other illustrations please.

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- Fossil reptiles make tracks



Carousel



Robin Cocks, former President of the Society, has been awarded the Lapworth Medal 2010 of the Palaeontological Association.

John Dickinson is now acting President of the South Midlands Institute of Mineral and Mining Engineers. This follows the sudden and untimely death of David Eastwood, Chartered and Euro Engineer.



Philip Gibbard (University of Cambridge) has been awarded an honorary doctorate degree (PhD *honoris causa*) by the University of Helsinki - the highest honour the University can bestow.

Stephen Sparks (University of Bristol) and former President of the Society, has been created CBE for his services to environmental science. The award recognises Professor Sparks's volcanological hazard research, and his scientific advice to government on issues including the eruption of the Soufrière Hills Volcano in Montserrat, radioactive waste disposal and the recent volcanic ash crisis.

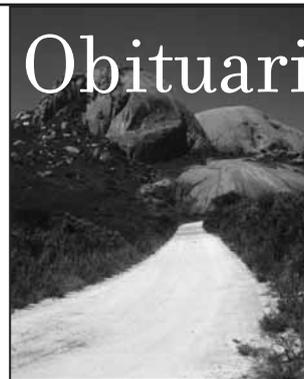


Hugh Torrens has been awarded the Founders' Medal of the Society for the History of Natural History.

Michael Welland has received the 2010 John Burroughs Medal for his book *Sand: The Never Ending Story* (UK title: *Sand: a journey through science and imagination*). The Medal honours the year's most distinguished natural history writing. 



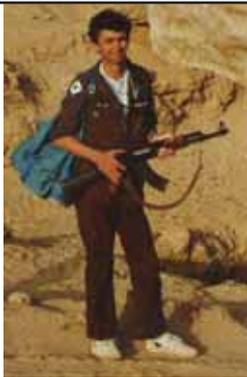
Obituaries



Obituaries will appear here as soon as possible after they are accepted and published at www.geolsoc.org.uk/obituaries. If you wish to write a Society obituary, please read the instructions to authors on this web page and contact Ted Nield to be commissioned ted.nield@geolsoc.org.uk. Please do not write anything until you have been commissioned.

DISTANT THUNDER





Graham Leslie Hopkins 1950-2009

Graham Leslie Hopkins, "Hoppy", died on 24 November 2009 aged 59. He had suffered from sarcoidosis for many years.

Graham was born in Llanelli, South Wales, and attended Llanelli Grammar School, and Bedford College, University of London, shortly after they began to admit male students. He graduated in hard rock

geology, and went to work for Goldfields in Kalgoorlie, Australia, where he hit and killed a kangaroo while driving through the outback. He left Australia following a gold price crash and returned to the UK to work for Exploration Logging, starting his career in sedimentology. ExLog sent him to Singapore, working on a number of rigs in South East Asia, including one on the site that became the epicentre of the 2004 Tsunami. After Singapore he worked in Nigeria and Portugal, before giving up ExLog to take the Imperial College Petroleum Geology Masters degree in 1975/76, under the aegis of Professor Dick Selley.

Graham then worked for Exploration Computing in London, using his offshore experience in digitising well-logs. During this time he was diagnosed with sarcoidosis, although the symptoms at that time were minimal, and did not prevent Graham from joining Total Oil Marine in Aberdeen in 1978. Here he played rugby and cricket, once commenting that in Aberdeen he never played cricket in fewer than three sweaters, and elsewhere never in more than two. Moving back to London from Aberdeen in 1981, he joined ARCO, during which time he published his

paper "Scales of Geologic Reservoir Description for engineering applications" with Roger Slatt, of ARCO and Arizona State University. The Hopkins family moved to Jakarta in 1989, where Graham worked on the Pagerungan block in Bali.

From Jakarta, Graham moved with ARCO to Sana'a, Yemen, although the family returned to London because of the precarious local political situation. From Yemen he returned to London and the North Sea, becoming a familiar face at PESGB meetings and PetEx. In 1988 he went to Port Gentil, Gabon on a short-term assignment, and was lucky enough to meet Nelson Mandela when en route through Johannesburg. After BP's takeover of ARCO in 1999, Graham moved to Doha, Qatar, to work for the Qatar General Petroleum Company, and lived in an apartment in a castle. This posting sparked his interest in birdwatching, all sightings being methodically catalogued on spreadsheets. Graham returned to London in 2001, and started work for CalEnergy, where he remained until his death. With CalEnergy he worked in Poland, and Perth, Western Australia, where drilling had to work around the migration patterns of local whales.

Graham was respected by his wide circle of contacts, and always happy to act as mentor to younger geologists - he was passionately enthusiastic about all geology and would fight his corner in technical discussions with great tenacity. His other passions were birdwatching and rugby, the Welsh team being the best in the world, even when they were losing! Graham is survived by his wife, Lorna Hawthorne, and their children, Rowan, a medical physicist, and Bryony, a final-year medical student.

Lorna Hawthorne 

Animal kingdom *a la carte*

Geologist and science writer Nina Morgan samples the fare at the Buckland dinner table...*

The household of the Reverend William Buckland, first Reader in Geology at Oxford University, was notorious for its eccentricity. Buckland's enthusiasm for the natural world and interest in animals even permeated the dining room of his house in Tom Quad at Christ Church in Oxford.

In his book *Reminiscences of Oxford*, the Reverend W Tuckwell recalls the "queer dishes garnishing the dinner table – horseflesh I remember more than once, crocodile another day, mice baked in batter on a third – while the guinea-pig under the table inquiringly nibbled at your infantine toes, the bear walked round your chair and rasped your hand with file-like tongue, the jackal's fiendish yell close by came through the open window, the monkey's hairy arm extended itself suddenly over your shoulder to annex your fruit and walnuts."

In his book, *Praeterita*, another visitor to the Buckland household, John Ruskin, recorded his regret when an "unlucky engagement" caused him to miss "a delicate toast of mice", but recalled "with delight being waited upon one hot summer morning by two graceful and polite Caroline lizards, which kept off the flies".

Living with and consuming so many different forms of life contributed to Buckland's great expertise and interest in animal anatomy. It also helps to explain why Buckland, on his wedding tour, viewed the sacred bones contained in St Rosalia's shrine at Palermo and confidently declared that they were not the bones of a woman – but of a goat.

Even so, it fails to explain how, many years later, Buckland was able to drop to the pavement in another foreign cathedral, touch his tongue to some dark stains reputed to be the blood of a martyr and exclaim with certainty: "I know what it is; it is bat's urine!" In all the contemporary reports that survive, bat's urine appears to be one of the few dishes that *never* graced the Buckland table. 

Acknowledgements

The stories about the Buckland menus, the saint's bones and the martyr's blood appear in *Reminiscences of Oxford* by Reverend W Tuckwell, published by Smith, Elder and Co., London, 1907. The incident about Ruskin is described in *The Curious World of Frank Buckland* by G H O Burgess, published by John Baker, London, 1967.

**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.



Laud of the isles

Alexis Drahos finds evidence of Turner's interest in contemporary developments in Earth science in his watercolour illustration for Sir Walter Scott's Lord of the Isles*

After a trip to the North of the Scotland during the summer of 1831, J.W.M. Turner (1775-1851) painted *Loch Coruisk* (Loch Coruisk), 1834, a watercolour that brings to the fore his surprisingly profound knowledge of geological form. The work is housed at the National Gallery of Scotland and belongs to Vaughan Bequest. At this time, Turner was creating illustrations to the works of Sir Walter Scott, and this watercolour was to form the frontispiece to Cadell's edition of *Lord of the Isles*.

In the fourth volume of *Modern Painters*, Ruskin (a keen geologist himself) paid tribute to the precision of Turner's geological observations. Turner had access to the Geological Society of London, founded in 1807, through his friendship with Charles Stokes and Francis Chantrey who were both prominent members. Stokes (1785-1853) was a wealthy stockbroker, amateur geologist, lithographer, antiquary, and collector. He was a Fellow of the Society of Antiquaries (1811) and of the Royal Society (1821) and later was elected Vice-President of the Geological Society. Stokes collected watercolours and Old Master prints widely, but Turner formed the core of his collection. He had a large collection of geological and natural history specimens, which Turner may well have seen.

Turner also knew the distinguished descriptive geologist John MacCulloch (1773-1835), from whom he acquired two volumes of

Geological Society's *Transactions*. Accounts in these volumes prompted Turner to tackle such subjects as *The Eruption of the Souffrier Mountains*, and *Staffa, Fingal's Cave*. He made studies of Stonehenge and the Isle of Staffa and even wrote verses using technical geological language.

Turner possessed more than a mere smattering of geology. Indeed, he appears to have had a profound knowledge of the new science. Turner was also probably aware of the scientific controversies of his time - not the least, those addressing the Earth's formation, including the debate between "Neptunists" and "Plutonists".

His watercolour plunges the viewer into one of the most dramatic scenery of Skye. Loch Coruisk is located in the Cuillin Mountains and is enclosed by rocks created about 55 million years ago by violent Tertiary volcanic activity that also created many of the Scottish Islands off the West Coast during the birth pangs of the North Atlantic. The so called "Red" and "Black" Cullins reflect geological differences in the composition (chemical and mineralogical) of the igneous rocks that form them (Red Cullins are made of a granite weathering to a reddish-pink, while the Black Cullins are largely made from gabbro).

In this picture, Turner focus on realistic details such as jagged mountains that bear witness to the role of the erosion over millions of years. This is not the first time that this painter has concentrated on such a scientific detail. In the early years of the 19th Century, Turner had already shown interest in cliffs and crags. His trip in the Alps, made during the Amiens Peace of 1802, was an opportunity to study the geology first hand, while other British painters (such as James Ward and later Charles Nemy) took a similar an interest in the depiction of cliffs, rocks and erosion. In this watercolour Turner has slightly exaggerated the steepness of the mountains, revealing his taste for the romantic. The grandeur of the scene comes very close to the sort of "sublime sentiment" enunciated by writer and philosopher Edmund Burke in 1757.

The cliffs are tinged with grey, blue and white and look like gigantic waves of stone. In the background, we observe purple on the slopes. In the foreground, two tiny persons are depicted, sitting on a cliff and bringing scale to the hugeness and the danger implicit in nature at her most violent and dramatic. Humanity is banished by this vastness, recalling Wordsworth's near terror in the "elfin pinnacle" incident from *The Prelude*, when "a huge Cliff/As if with voluntary power instinct/Uprear'd its head" and seemed to pursue him, through the thoughts of his days and dreams of his nights. More than any other picture of his output that depicts mountains, in *Loch Coruisk* Turner gives us a truly dynamic picture of nature in the raw.

Turner concentrates on the relationship between meteorological and geological phenomena at a time when the two sciences

Deaths

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

The Society notes with sadness the passing of:

Badham, Nick*

Davies, Rhys*

Locke, Matthew*

Mann, Paul Dunstan*

Morley, William*

Pearson, Christopher Martin *

Whittington, Harry*

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

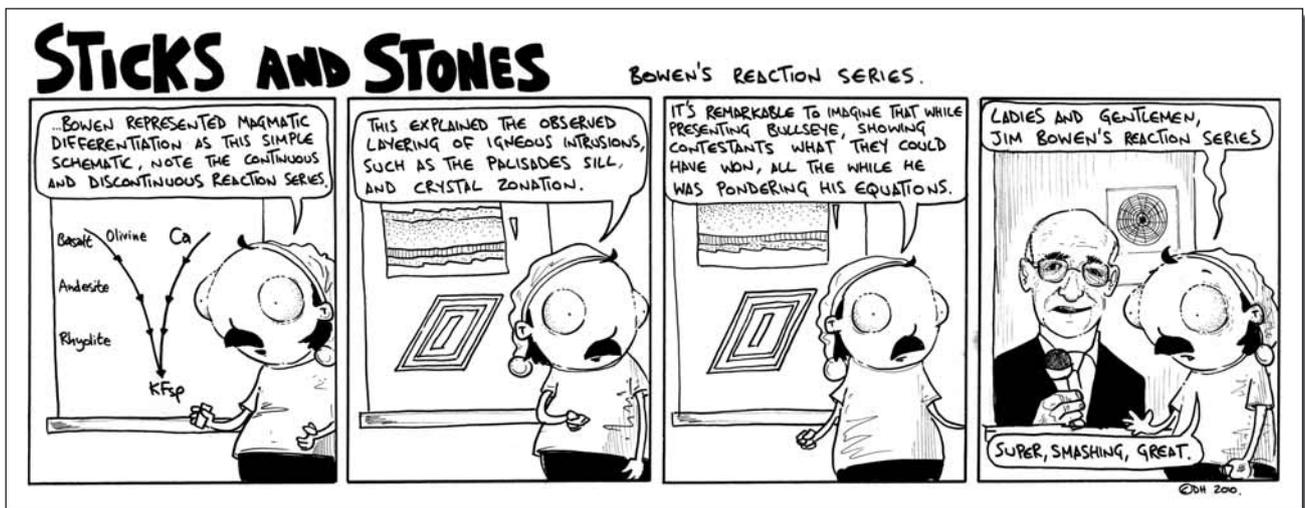
The Society operates a scheme whereby Fellows may deposit biographical material for use by their obituarist. The object is to assist obituarists by providing useful contacts, dates and other factual information, and thus to ensure that Fellows' lives are accorded appropriate and accurate commemoration.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

were still closely related. In Turner's time, in scientific institutions such as the Geological Society and Royal Society, the natural sciences were perceived as an interconnected web: chemistry, geology, natural history, astronomy and even mathematics depended closely one upon the other – the kind of amalgamation that is only now recurring as natural sciences reunite under the banner of Earth System Science. 

Further reading

Finley, Gerald 1980: *Landscapes of Memory – Turner as Illustrator to Scott*, University of California Press.

*Dr Alexis Drahos is an art historian specialising in 19th Century landscape painting and the new science of geology. He lives in Paris.



Reviews

Copies available for review:

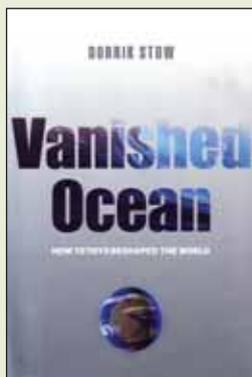
 Huddart, D. & Stott, T. (2010), *Earth Environments: Past, present and future*, Wiley-Blackwell.

 Testa, S. (2009), *One Man's Planet: Earth in today's political culture*, The American Geological Institute.

 Trewin, N. & Hurst, A. (eds) (2009), *Excursion Guide to the Geology of East Sutherland and Caithness*, Dunedin.

 Wangen, M. (2010), *Physical Principles of Sedimentary Basin Analysis*, Cambridge.

Interested parties should contact the **Reviews Editor, Dr. Martin Degg 01244 513173; m.degg@chester.ac.uk**, only. Reviewers are invited to keep texts. *Review titles are not available to order from the Geological Society Publishing House unless otherwise stated.*



Vanished Ocean – How Tethys reshaped the world

Dorrik Stow

Published by: Oxford University Press

Publication date: May 2010

ISBN: 978-0-19-921428-0 (hbk)

List price: £16.99

300 pp

www.oup.com

Tethys was perhaps the most prodigious sea the Earth has ever seen. Born amid the worst mass extinction in history, Tethys witnessed the subsequent recovery, the dinosaurs' long rise to dominance on land, and their extinction. It saw much else besides, and its astonishing biological productivity gave us the source rocks from which about 70% of all our oil is derived.

As Pangaea cracked up around it (to form the continents we know today) Tethys survived long enough to witness much of Earth history – including the sudden catastrophic global warming 55 million years ago that is perhaps our closest analogue for what is happening today, albeit this time with our species' enthusiastic encouragement. As the shards of the shattered supercontinent spread across the globe, Tethys became a seaway. Then, Africa and Europe finally touched at the Strait of Gibraltar; Tethys's last westerly remnant became isolated and simply evaporated away.

Stow sets himself the task of narrating the biography of this vanished ocean whose life spanned nearly 200 million years. In pursuing his chimerical sea, Stow has sailed every ocean (except, of course, the one that remains most dear to him) and re-tells her tale through a personal autobiographical voyage of discovery. We find him first in Spain, finishing his book; on drill-ships in mid-ocean, piercing the seabed miles below. We travel to North Africa, the Middle East, China, Russia and the Americas; sometimes in comfort, more often discomfort - and narrowly escaping kidnap in Kashmir. As such, this book is a paean to the life of a working geologist travelling the globe, largely at other people's expense, visiting places where others shall never go - and angels would fear to tread.

Along the way, Stow creates an introduction to the Earth sciences. He explains plate tectonics, the supercontinent cycle, ocean circulation, the origin of oil, and extinction events – which he attributes to multiple causes, contradicting the brouhaha surrounding the rather exceptional fact that the dinosaurs were uniquely helped on their road to oblivion by the arrival of a massive meteorite. *Vanished Ocean* is a wealth of nourishing knowledge revealed through the history of the Tethyan Realm. Yet, its chronological chapters, each devoted to a key event in the life of the ocean, with lengthy background explanations further expanded by personal anecdote, often lose touch with the central tale and sadly rob the book of narrative drive.

Nevertheless, *Vanished Ocean* is an ideal general reader for students and those who are already widely read in natural science. It should appeal strongly to legions of former science students who, having since made their way in the world as accountants and personnel managers, hanker for a refresher course, and for the interest and excitement of a life they once glimpsed but were unable to grasp.

Ted Nield



The Hockey Stick Illusion - Climategate and the corruption of science

A W Montford
Published by: Stacey International
Publication date: 2010
ISBN: 978-1-906768-35-5
List price: £10.99
482 pp

www.stacey-international.co.uk

In 1998 a graph, which was to become famous as the 'Hockey Stick', made its debut in the pages of the prestigious journal *Nature*. The graph, constructed by climate scientist Michael Mann and colleagues, purported to show that late 20th Century temperatures were unprecedented in at least 1000 years. For many this was the smoking gun of Anthropogenic Global Warming (AGW). Before long the Hockey Stick became the icon of the International Panel on Climate Change (IPCC) and took (unacknowledged) centre-stage in Al Gore's film *An Inconvenient Truth*. The scientific community immediately, and virtually unanimously, accepted the Hockey Stick at face value, even though it eliminated such familiar episodes of climatic history as the Medieval Warm Period and the Little Ice Age; these were explained away as regional or diachronous phenomena.

Not everybody, though, was prepared to take this new climate history on trust. Foremost among these sceptics was a Canadian mining engineer, Steve McIntyre. Over several years, in the teeth of resistance from the paleoclimatological community, he laboriously collected the raw data (mainly tree ring measurements) from which the Hockey Stick was derived. McIntyre identified numerous shortcomings with the reconstruction. The charges included cherry picking of data, use of invalid proxies and poor statistical techniques, which together produced a picture of exceptional 20th Century warming that was not present in the underlying data.

The response of the 'Hockey Team' (as Mann and colleagues came to be known) was to circle the wagons. McIntyre was dismissed as a crank, or a flunkey of the oil companies. Attempts were made to prevent publication of his analyses in the scientific press. When these tactics failed to silence him, the Hockey Team claimed that many independent studies confirmed their results. McIntyre, though, was able to show that these 'independent' studies used the same flawed data sets and techniques as the Hockey Stick and inevitably reached the same erroneous conclusions. The debate eventually reached Washington where

two congressional committees concluded that Mann's statistics could not support the conclusions he drew from them. Nonetheless the Hockey Team, with the support of the IPCC, pressed ahead with their depiction of the Hockey Stick as 'settled science'.

Andrew Montford tells this detective story in exhilarating style. He has assembled an impressive case that the consensus view on recent climate history started as poor science and was corrupted when climate scientists became embroiled in IPCC politics. His portrayal of the paleoclimatology community is devastating; they are revealed as amateurish, secretive, evasive and belligerent. But the most serious charge is that they have simply failed to demonstrate any scientific integrity in confronting McIntyre. The University of East Anglia emails, which appeared just as Montford was completing his book, suggest that the Hockey Team were more interested in knobbling McIntyre than in addressing his arguments.

The wider scientific community does not escape criticism. No serious effort was made to subject the Hockey Stick to independent scrutiny, despite its profound implications for the future of the planet and its inhabitants. In response to external challenge the scientific establishment's reflex action was to side with the palaeoclimatologists without bothering to check the evidence. This approach, no better than that of any other vested interest group, should dismay everyone of genuine scientific spirit.

Montford's book ends on what is perhaps an inevitable low note, because the Hockey Team has not conceded that its temperature reconstructions are seriously flawed. However, if *The Hockey Stick Illusion* provokes a truly independent review of the evidence it will have served its purpose.

Joe Brannan

Tertiary to-do

*Andy Gale, Chairman of the Geological Society Stratigraphy Commission, writes: Should we stick with the “Tertiary” or scrap it? Opinion remains divided. The following piece (Knox *et al.*) represents the view of the majority of Commission members. The minority view opposed to Commission’s proposal is presented in the article by Pearson *et al.**

Tertiary: survival of the fittest?

by Robert Knox, Phil Gibbard, John Cope, Andy Gale, John Powell, Peter Rawson, Alan Smith, Colin Waters and Jan Zalasiewicz

Although used for nearly two centuries as a standard, universal stratigraphic term, the Tertiary has been absent from the International Union of Geological Sciences (IUGS) approved timescales since 1989, with the interval between the Cretaceous and the Quaternary being represented solely by the Paleogene and Neogene periods.

More recently, the Quaternary was similarly omitted from an International Commission of Stratigraphy (ICS)-sponsored time chart; although this move was not sanctioned by IUGS. Strong objections to this apparent suppression were immediately raised and led to extensive discussion between those for and against its reinstatement. The matter was finally settled by the IUGS Executive Committee on 29 June 2009, with the formal ratification of the Quaternary as a period/system within the geological timescale. The Quaternary is thus here to stay as a formal unit.

The ratification of the Quaternary puts a new perspective on the discussion regarding the status of the Tertiary. The Tertiary has never been explicitly eliminated by IUGS, and has continued to be used in an informal sense, alongside the Paleogene and Neogene. One of the arguments put forward against retention of both the Tertiary and Quaternary is that they are relics of a redundant 18th Century system that originally included the Primary and Secondary. To equate the terms Tertiary and Quaternary with Primary and Secondary is quite unjustified, however, since Primary and Secondary were abandoned long ago. Clearly, the recent IUGS ruling on the retention of the Quaternary counters any argument for eliminating the Tertiary on the basis of its 18th Century roots.

The other main argument for abandoning the Tertiary is that the term has fallen out of use. Thus in 2005 the ICS recommended that the Tertiary not be considered as a formal division of the geological timescale, “because it is nearly redundant with the entire Cenozoic Era”. This statement was refuted by the late Amos Salvador, who pointed out that in 2006 the term Tertiary was being used more often than the terms Paleogene and Neogene. Continued usage of “Tertiary” is not confined to individual articles and books. It has also been retained by some national stratigraphic commissions, (eg., the German Stratigraphic Commission) by some national geological mapping organisations, [eg. the German Bundesanstalt

für Geowissenschaften und Rohstoffe (BGR) and the Bureau de Recherches Géologiques et Minières (BRGM), and in some national geological survey time-charts (eg, USGS)]. Clearly, the Tertiary has by no means fallen out of use, despite its omission from the ICS charts.

Recent arguments for the reinstatement of the Tertiary as an officially sanctioned unit have been based primarily on its role as a practical time unit, referring to the post-Mesozoic– pre-Quaternary interval.

The continued use of the term Tertiary clearly reflects the need by many geoscientists for a single term that encompasses both the Paleogene and the Neogene. The reason for this may lie in the origin of the Paleogene/Neogene division. The term Neogene originated in Europe, where it was applied to younger Tertiary (Miocene and Pliocene) strata that rested unconformably on Eocene strata (and thus post-dated the climax of the Alpine orogeny). The term Paleogene was introduced initially to equate with the Eocene and was subsequently expanded to include the Paleocene and Oligocene. In its original concept, therefore, the division of the Tertiary into the Paleogene and Neogene was tectonostratigraphic as well as biostratigraphic in nature. Although the tectonostratigraphic element of the definition soon became sidelined, the application of the terms Neogene and Paleogene for many decades applied only to those regions affected by Alpine tectonism.

While the Paleogene and Neogene have subsequently acquired international recognition, it is open to question whether they represent appropriate divisions of time at the period/system level. In recent decades it has become increasingly apparent that the most fundamental and permanent change in post-Cretaceous, pre-Quaternary global climate and environments between the Cretaceous and the Quaternary took place at the Eocene–Oligocene transition, marking the change from a greenhouse to an icehouse world (Figure 1). The Paleogene/Neogene boundary does not reflect this, and this may be one reason why many stratigraphers prefer to retain the Tertiary as the fundamental unit of time (ie. period) between the Cretaceous and the Quaternary.

It should also be pointed out that, at the time the decision was made to give formal period rank to the Paleogene and Neogene, no compromise seemed possible with the Tertiary/Quaternary scheme. This is because the Neogene extended beyond the Tertiary/Quaternary boundary. Following the recent decision to terminate the Neogene at the base of the Quaternary, this barrier to integrating the two schemes no longer exists, and we have a unique opportunity to give due recognition to both historical schemes for subdivision of Cenozoic time at the Period level.

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Whatever the motivation, the continued use of the term “Tertiary” speaks for itself. In our opinion, therefore, the time interval between the end of the Cretaceous and the beginning of the Quaternary is best represented by a single period: the Tertiary (Figure 2). The GSSP for the base of the Tertiary Period/System would be that already established for the Paleogene, at El Kef, Tunisia. The Tertiary would thus have the same status as the Quaternary. One significant effect of the assignment of period status to the Tertiary would be the downgrading of the terms Paleogene and Neogene. It is clearly in the interests of stability of nomenclature that these terms be maintained, and we recommend that the Paleogene and Neogene be given sub-period/sub-system status, with their meaning remaining unchanged. It may be noted that units of sub-period/sub-system level already exist in the ICS/IUGS nomenclature, i.e. the Mississippian and Pennsylvanian divisions of the Carboniferous Period.

Having all three terms available as formal chronostratigraphic/geochronological units is considered to provide the most pragmatic solution to this long-standing controversy. The proposed scheme provides geoscientists with the most versatile vocabulary for expressing post-Cretaceous, pre-Quaternary time.

- For recommended reading please see the online version of this article.

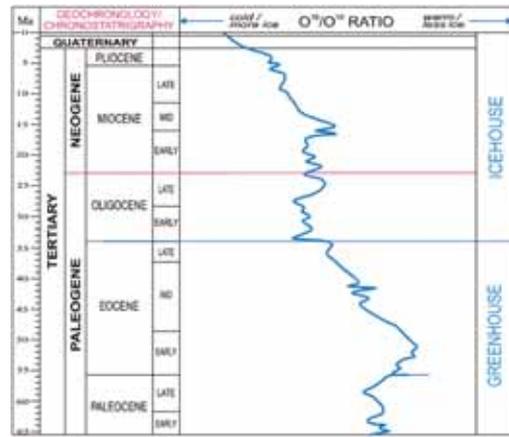
Retain “Paleogene” and “Neogene” as periods

by Paul Pearson, and Mark Hounslow*

In response to Knox *et al.*, and as an opposing viewpoint, we note that reinstating the Tertiary on the ICS / IUGS standard timescale and removing the ‘period’ status of Paleogene and Neogene would promote inconsistency. Moreover as a formal stratigraphic unit, the Tertiary has little intrinsically to recommend it.

As Knox *et al.* point out, the term ‘Tertiary’ remains in widespread use in some parts of the geological community. Equally, personal experience shows that it is obsolete in others - for example, among deep-sea Cenozoic stratigraphers and palaeoclimatologists. Meanwhile Paleogene and Neogene have achieved widespread acceptance as period-level divisions, and have been recognised as such for decades. We have no objection to informal use of the Tertiary; the issue is whether the ICS / IUGS should revert to using it on the official timescale, having previously omitted it, and at the same time downgrade Paleogene and Neogene to sub-period status. This move would force considerable change on stratigraphers. Such a decision should only be taken if there is an overwhelming case and solid support; but the community is evidently divided following the recent decision to recognise the Quaternary as a period. Aside from the politics of the situation, there are several shortcomings inherent in the concept of the Tertiary as presented by Knox *et al.*:

1. As there is no intention to abolish Paleogene and Neogene but rather to downgrade them to sub-periods, the proposal adds a level of hierarchy to the formal timescale. Sub-periods are not recognised for most of the Phanerozoic. The proposal would lock in this unnecessary complexity for future generations of geologists to learn.
2. Knox *et al.* question whether the Paleogene/Neogene periods represent appropriate divisions of time at the period/system level. We note that their durations (42.5 and 20.4 million years respectively) are in fact reasonable in the context of the Phanerozoic as a whole, being similar to the Ordovician [44.6 m. yr] and Silurian [27.7 m. yr] periods, for example). In contrast the Tertiary and Quaternary have a very large discrepancy in their respective



Tertiary Figure 1

PRESENT PROPOSAL											
Era	Period	Sub-period	Epoch	Sub-epoch	Age	Age (Ma)					
Cenozoic	Quaternary		Holocene			0.012					
			Pleistocene	Upper		0.126					
				Calabrian		0.781					
	Tertiary	Neogene	Pliocene	Gelasian		1.806					
				Zanclean		2.988					
				Piacenzian		3.600					
		Paleogene	Neogene	Miocene	Messinian		5.332				
					Tortonian		7.246				
					Serravalian		11.600				
					Langhian		13.822				
					Burdigalian		15.971				
					Aquitanian		20.437				
					Paleogene	Paleogene	Oligocene	Chattian		23.031	
								Rupelian		28.4	
								Priabonian		33.9	
								Eocene	Bartonian		37.2
									Lutetian		40.4
								Paleogene	Paleogene	Paleocene	Ypresian
Thanetian		55.8									
Selandian		58.7									
			Danian		61.1						
					65.5						

Tertiary Figure 2

- durations (63 vs 2.6 million years). In the Knox *et al.* scheme the Paleogene sub-period is over 16 times longer than the Quaternary period! This hardly seems a rational way of parcelling geological time, particularly when a fine-scale orbital chronology is now available for most of the Cenozoic.
3. We have the ‘Cenozoic era’ to express the biologically important interval of time from the Cretaceous/ Paleogene boundary to the Recent. It is not evident that “we also need a single term that encompasses

both the Paleogene and the Neogene” as Knox *et al.* suggest. Because the Tertiary is essentially the Cenozoic minus the Quaternary, with the boundary set at an arbitrary level, it has almost no intrinsic coherence either in a palaeoclimatic or biological sense. It is, in effect, a stratigraphic ‘wastebasket’ left over from recognising the Quaternary as a period.

4. Significant biotic and climatic events mark the Paleogene-Neogene transition, including a supposed glacial episode known as ‘Mi-1’ and the first radiation of some important Neogene fossil groups. However we do acknowledge that, as Knox *et al.* point out, a more natural place for a mid-Cenozoic ‘break’ might be found in the complex series of events known as the Eocene–Oligocene transition. This, however, seems more of an argument for lowering the Paleogene/Neogene period boundary rather than downgrading them to sub-periods.

In summary, stability is best served by retaining the Paleogene and Neogene as periods and the Tertiary should be left as an informal unit of only historical relevance. 

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• What do you think?

Write to Andy Gale
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Stratigraphy Commission and/or to
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for publication.



The E-Den Project

We sent Sarah Day on a field trip to Soho Square, where she encountered an unlikely Cornish visitor, spreading the word about renewable energy.

Is it a golf ball? An igloo? No, it's an ‘E-Den’. Inspired by the Eden Project, the bizarre-looking structure arrived in Soho Square last month, to house representatives from a variety of businesses hoping to raise awareness of Cornwall’s pioneering work in renewable energy. The dome is the creation of InvestInCornwall, which is promoting the county as a business destination, and a leader in the UK’s low carbon revolution.

“Cornwall has fantastic resources”, says Peter Ledingham, Operations Director for GeoScience Limited. “As well as geothermal resources, it’s surrounded on three sides by the ocean, so it has wave, tide and wind resources as well”.

It is the potential for geothermal energy resources which makes Cornwall a particularly attractive area for businesses. “Cornwall has by far the best geothermal resources in the UK”, says Ledingham. “The whole of the county is underlain by a granite which is heat producing – the heat flow is about double the national average. That means you can reach commercial temperatures with shallower drilling, and that’s a very big part of the economic case for geothermal development”.

GeoScience Ltd are planning a pilot project in Cornwall which hopes to begin drilling in January 2011, with a power station up and running by 2014 – all subject to funding. But theirs is not the only project underway.

“There are two other projects, like ours, which have sprung up completely independently of each other. I think that’s great – it shows how great the resources are in Cornwall” says Ledingham.

One is being led by the Eden Project which, as well as being a centre for conservation and education, is enthusiastic about the potential for

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developing renewable energy technology, both in Cornwall and further afield. “It’s something we’re very keen on”, says Dan James, Development Manager at the Eden Project, “particularly low carbon energy. In Cornwall we see ourselves as having a fantastic opportunity to use the county’s assets as a way of creating a new economy for ourselves. Traditionally we’ve focused on farming, fishing and tourism – generally low paid, low skilled jobs. The environmental technology centre could be a way of up-skilling our population and making ourselves more competitive”.

If the project is successful the Eden Project itself could end up being powered solely by geothermal energy. Currently, holes are being drilled in one of its car parks, to see if the granite is a rich enough heat source. If that works, there are plans to use the energy more widely; in particular in one of the government’s eco-town projects.

“One of the sites is about a mile away from the Eden Project” says James, ‘so we’re looking at pumping some of the heat through to that site as well. We’re thinking that if our site works as a pilot then they might want to build more in the ecotown programme, and hopefully more across Cornwall”.

Geothermal energy is nothing new, particularly in Cornwall, where a great deal of research was carried out in the 1970s and 80s. So why is there so much interest in developing projects now?

“I think it’s because the economic climate has changed”, says Ledingham. “Also the technology for generating electricity has changed, and the

willingness to look seriously at renewable energy is much greater than it was 25 years ago when the last geothermal research work was done in Cornwall. The time is right now to have another go at it”.

For Eden, it is not just about generating new energy sources. Geothermal research is forming an integral part of Eden’s project to inspire a new generation of youngsters to view the environment as an important part of their future careers.

“Part of the reason we’re here is to promote a project we’ve just got funding for called Green Talent”, says James, “which will take 5000 14 to 19 year olds through a ‘green induction programme”.

In partnership with Kew Gardens, the RSPB and the Institute of Business and Education, the project will take the students on a week long induction programme at either Eden or Kew, to give them an insight into the impact the environment will have on future employment opportunities.

Says James: “Hopefully it will get them excited, and thinking of the environment as a career opportunity for them. Once they’ve finished the programme, we send them off to do work experience through companies who are currently looking at how the environment is impacting on how they run their business, to give them a practical experience of how it all works”. 

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An Ordovician "Burgess Shale"

Palaeontologists have extended the range of Burgess Shale type fossils by nearly 20 million years, Ian Randall reports.

A team of researchers from Yale University has uncovered a rich collection of marine organisms, including those of the iconic types originally found in the Burgess Shale, from around Morocco's Draa valley. Yet this unbelievably well preserved cache comes with a more fantastic twist: rather than being from the Cambrian, like their Burgess Shale counterparts, the creatures hail from the early Ordovician – 19 million years later.

Over 1500 marine fossils have been recovered since the expedition began studying the region last year. The creatures, many of which are unique, were first noted by a local collector, Mohammed Ou Said Ben Moulla. The animals, which would have lived between 480 million and 472 million years ago, are the earliest known soft-bodied creatures to have been preserved from the Ordovician Period.

A large number of the finds, which are reported in a recent issue of the journal *Nature*, are complete specimens. Most have been flattened under the pressure of overlying sedimentation, although some of the worms do show a degree of three-dimensional preservation.

The fossils are mainly of benthic creatures and, while some were more complex animals with hard shells and exoskeletons (such as echinoderms, molluscs, trilobites and even a species



Xiphosurid with fused preabdomen, Upper Fezouata Formation (YPM 227586).



Photo: Martin Lack

Cold water poured on cooling theory

Geologists find no evidence for increased erosion after uplift of Himalayan Plateau, casting doubt upon this as a cause of Cenozoic global cooling, reports Sam Shead.*

As the world's great mountain ranges have been uplifted, the Earth's continents have been subject to higher rates of erosion and thus increased weathering. An increase in erosion results in a greater flux of material into the world's oceans. About 20% of the global

suspended and dissolved sediment today derives ultimately from the Himalaya and the Andes.

Cenozoic global cooling can be linked to this sedimentation flux because as carbon dioxide is extracted from the atmosphere it combines with water to form a weak carbonic acid, which acts as a weathering agent. Silicate weathering products remain high in carbon, which is thus extracted from the atmosphere and sequestered beneath the sea. The heightened drawdown of atmospheric carbon, particularly after the uplifting the Himalayas, has been cited as a potential cause for the Cenozoic change from "greenhouse" to "icehouse" conditions on Earth.

A controversial study by Jane Willenbring and Friedhelm von Blanckenburg¹ (GFZ, Potsdam) suggests that the rise of mountain ranges has not in fact altered the amount of eroded material being transferred from the continents to the oceans. They show, by contrast, that the global flux of eroded material has remained roughly constant throughout the Late Cenozoic (the last 40 million years). They further suggest that the observed increase in sedimentation flux over the last five million years has been caused by bias in observation and measurement.

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that greatly resembles the modern-day horseshoe crab – the first known of its kind), two-thirds of the specimens collected so far are soft-bodied.

“A striking feature is the high number of [these] organisms archetypal of Cambrian Burgess Shale-type faunas, including various demosponges, annelid worms, and other stem arthropods,” said Peter Van Roy, the Yale palaeontologist who led the expedition.

Until now, we had an incomplete understanding of the creatures that populated our oceans in the Ordovician period – a time in which, following the emergence of complex animal life in the Cambrian Explosion, the oceans played host to an exponential increase in the variety of life. This growth in diversity took place over a 25 million year period, grandly named ‘The Great Ordovician Biodiversity Event’.

The rocks here, from the Lower Fezouata Formation, are mainly mudstones and siltstones, implying a deep-water setting at the time of deposition; while the fossilised tissues, which are concentrated in distinct lenses, are coloured in reddish-browns and yellows. The low levels of bioturbation show us that the waters of the time were mostly calm, with occasional bouts of rapid burial, indicated by the occasional layers of coarse sandstone and shell fragments – most likely brought on by heavy storms.

“The early Ordovician was a critical moment when massive diversification takes off, but we were only seeing a small piece of the picture that was based almost exclusively on the shelly fossil record,” said Derek Briggs, director of the Yale Peabody Museum of Natural History. “Normal faunas are dominated by the soft-bodied organisms we knew were missing, so these exceptionally well-preserved fossils have filled in much of the missing picture.”

Beyond expanding our general understanding of Ordovician life, however, the Moroccan finds have dispelled the long-held notion that the Burgess Shale-type faunas became extinct at the end of the Middle Cambrian, 499 million years ago.

“It shows that their absence from the fossil record is just preservation – it has nothing to do with extinction. It’s just a matter of finding the right rocks from the right setting,” Van Roy adds.

This expedition, however, is believed to have merely scratched the surface of what the Lower Fezouata deposits have to teach us about the early evolution of life.

“We are going to continue working on these sites because, at the moment, we have just seen the tip of the iceberg,” Van Roy added. “I’m certain there will be more spectacular fossils coming out of this site in the near future.”

Reference

Peter Van Roy, Patrick J. Orr, Joseph P. Botting, Lucy A. Muir, Jakob Vinther, Bertrand Lefebvre, Khadija el Hariri, Derek E. G. Briggs *Ordovician faunas of Burgess Shale type*. *Nature* 465, 215–218 (13 May 2010)

*Ian Randall is geologist studying journalism at City University and is working as an intern on *Geoscientist*.

• Readers’ attention is drawn to the announcement in this issue of the death of Wollaston Medallist and doyen of the Burgess Shale’s re-examination in the 20th Century, Professor Harry Whittington – p7. *Editor*

It is possible to measure erosion rates at points in the past by analysing the mass of sediments in basins. However, a previously neglected complication arises because eroded material is often subject to subsequent re-erosion. The timescale here is of key importance, because the probability of a sediment body suffering such recycling increases with age. Willenbring and von Blanckenburg claim that once this additional erosion is taken into account, erosion rates on the continents turn out to have remained roughly constant.

However, this conclusion implies that CO₂ drawdown through silicate weathering also remained constant. The authors test for this by using beryllium isotopic evidence from deep-sea sediments spanning the past 10 million years of Earth history. These studies also suggest that silicate weathering has indeed remained constant; though the major uplift phases (not to mention a large amount of Cenozoic cooling) occurred earlier than 10Ma. For that reason, Willenbring and von Blanckenburg face the challenge of extending their record further back in time.

The authors conclude that the global climate cooling in the Late Cenozoic had no link to geologically recent mountain uplift – a view supported by a number of CO₂ archives, which also suggest little change in CO₂ atmospheric concentrations during the past 20 million years.

The results seem paradoxical. We know that weathering is more intense at higher altitudes – how therefore is it possible for global sedimentation flux and

silicate weathering to remain constant for 10 million years while large mountain uplift was taking place?

One possible explanation is that there could have been a coeval decrease in erosion outside uplifted regions. There is also a possible climatic link, such as a reduction in water runoff brought about by drier conditions and the growth of large stable ice sheets. These factors would essentially counterbalance the effect of increased erosion in uplifted regions.

More evidence is needed but if the authors are right, and are able to show that their findings also applied during the last 40Ma, then the implications could seriously undermine some of the most basic concepts in our understanding of climate and surface processes.

Reference

Jane K. Willenbring & Friedhelm von Blanckenburg: *Long-term stability of global erosion rates and weathering during late-Cenozoic cooling* *Nature* 465, pp 211–214 13 May 2010.

* Sam Shead, Royal Holloway University of London, is working as an intern for *Geoscientist*. He is about to take up a place at the Cardiff University School of Journalism.

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Arctic Russia: minerals

Arctic Russia is rich in resources, sparsely populated and politically significant. Now environmental change is opening up this area to mineral exploration and exploitation. Geoff Glasby and Yuri Voytekhovskiy explore the potential of this vast region, remote even from Moscow.*



and mineral resources



Arctic - squaring the circle

Whether you define Arctic Russia as north of the 10° latitude line, or as the area where the average temperature in the warmest month lies below 10°C (Figure 1 – red line), it encompasses parts of the Russian mainland and some major islands. Murmansk is its only ice-free port, so the development of icebreakers was crucial to opening up the Russian Arctic. The first icebreaker aimed at supporting regular navigation along the northern coast of Russia, the *Krasin*, was built in Newcastle in 1916 by order of the Russian Maritime Ministry.



Figure 1: Schematic map showing the Arctic region based on the definition the average temperature in the warmest month falls below 10°C. The 10°C isotherm is marked in red. Map shows sea ice on 14 September 2008, the date of the minimum, when ice extent was 4.52 million square kilometres. Yellow line marks the extent for September 16, 2007. Courtesy, National Snow and Ice Data Center.



Few people will have missed the news on 1 August 2007, when Russia used two *Mir* submersibles to perform the first manned descent to the seabed under the geographical North Pole at 4261m in relation to Russia's territorial claim to the region made in 2001. The rationale for this expedition was, of course oil. Russia is claiming the right to the oil, gas and minerals of the Arctic Ocean up to the North Pole, based on the extension of the Lomonosov Ridge, which runs 1210 miles from Siberia through the North Pole almost to the junction of Ellesmere Island and Greenland. US geological data suggest that the Arctic Seabed contains up to 25% of the world's oil and natural gas reserves and other mineral resources, which are now being made accessible by receding polar ice as global warming continues.

In the west, several commentators described the dives as a "stunt" but, in this, they were underestimating a formidable achievement. At the seafloor, the *Mir* crew planted a one-metre tall Russian flag made of titanium alloy, and collected sediment samples. The descent was supported by the nuclear powered icebreaker *Rossiya* with the power to negotiate the most challenging ice in the Arctic Ocean. When the submersibles ascended, the pilots – led by Anatoly Sagelevich, Russia's most experienced submersible pilot – had to locate the



hole through which they had descended, which had already drifted by one mile. Sagelevich was awarded the title Hero of the Russian Federation for "courage and heroism shown in extreme conditions and successful completion of the High-latitude Arctic Deep-Water Expedition".

The hydrocarbon potential of the Arctic is important to Russia: 91% of natural gas production and 80% of Russia's explored reserves of explored natural gas lie there. The Arctic also contains 90% of its offshore reserves. It has been estimated that the recoverable reserves of the oil and gas fields of the Russian continental shelf amount to 100 billion tonnes (13% oil, 87% gas). Of these fields, 44.4% are located in the Kara Sea, 25.6% in the Barents Sea, 8.8% in the Okhotsk Sea and 5.1% in the Pechora Sea. In the Okhotsk Sea, $3.5 \times 10^9 \text{m}^3$ of gas hydrates were identified within an area of about 4.36km^2 . Overall, it is estimated that between 2×10^{14} and $7.6 \times 10^{18} \text{m}^3$ of gas hydrates are located on the world's continental shelves, making these deposits a huge potential resource. However, most of the gas hydrates exist close to their stability boundary, and minor changes in temperatures and pressure could lead to huge gas emissions. Nonetheless, both Japan and the USA plan to start commercial production of gas hydrates between 2010 and 2015.

Beyond petroleum

Interest in Arctic Russia is not confined to hydrocarbons. According to Burakova, the estimated value of Arctic minerals stands at \$1.5-2 trillion. In addition, 25 mines were already

operating in Arctic Russia in 2006. Most were nickel-copper mines; but tin, uranium and phosphate were also being extracted. There are also abundant placer deposits on the continental shelves, of which gold and tin are economically most important. Placer diamonds, amber and fossil ivory are also present. Of the bedrock deposits, a few tens of millions of tonnes of lead-zinc carbonate deposits have been located on the Novaya Zemlya Archipelago. Manganese is mainly associated with carbonate ores in Permian deposits in Novaya Zemlya, which are estimated to contain three billion tonnes of ore to a depth of 500m.

Of particular interest are the huge deposits of nickel, which were discovered at Pechenga in Finland in the 1930s. After the war, Norilsk Nickel plant became the largest mine in the Russian Arctic, best known for its high levels of pollution (mainly sulphur dioxide), which caused major health and environmental problems and created a barren area for kilometres around. The plant was closed in 2008 because of this extreme pollution. In July 2007, the last measurement of SO_2 concentrations at the monitoring stations showed a median value of 7500 milligrams sulphur per m^3 for one hour, more than 20 times more than the maximum recommended level of 350 milligrams per m^3 . Later, the Norilsk Nickel plant amalgamated with the Severonickel and Pechenganickel plants in the Kola Peninsula. Although the conditions encountered at the Norilsk Nickel plant were extreme, they are typical of many of the smelters in Russia, which are surrounded by barren areas stretching for miles. As a result of SO_2 emissions, Arctic



haze is a common phenomenon in northern Russia. Norilsk Nickel is now one of the biggest mining groups in the world. In 2007, it produced 18.8% of the world's nickel, 46.3% of the world's palladium and 12% of the world's platinum.

Environmental pollution

The Russian Arctic is now far from being a pristine wilderness, thanks to waste discharges from offshore oil and gas activity, smelting and nuclear weapons testing.

It is also widely accepted to be severely affected by global warming. A detailed study of growth rings in juniper trees from at 69° N, 33° E in the northern Kola Peninsula (2004) provided a 676-year chronology, which showed a close relationship to known global palaeo-temperatures in Europe. Records were also taken of summer temperatures at this location between 1920 and 2000, which showed a steady decrease in temperature of about 0.2°C over this period. (Although Shumilov and his colleagues have ascribed past climate changes in the Kola Peninsula to fluctuations in solar and galactic cosmic ray activity rather than increases in atmospheric CO₂ concentrations.)

Over the next 15 years, global warming is expected to shorten significantly the period over which sea ice remains impenetrable in these waters. In the oceans,

the seasonal minimum for Arctic ice in 2008 was recorded (on 14 September) at 4.52 x 10⁶m³. This was the second lowest value ever recorded and it was estimated that, at the present rate of melting, the Arctic would have no sea ice left by 2060.

“ The estimated value of Arctic minerals stands at \$1.5 - 2 trillion. ”

Arctic haze, a visible reddish brown haze at high latitudes, was first noted in the 1950s by Canadian pilots, who were puzzled by low visibility over pristine ice. The haze contains gaseous species such as SO₂ and NO_x as well as aerosols containing SO₄²⁻, H⁺, NH₄²⁺ and metals.

The haze is seasonal and peaks in spring. It is most severe when stable high pressure systems produce calm, clear weather at mid-latitudes. It was long thought to be caused by coal-burning at mid-latitudes. However, recent evidence suggests that it may, in fact, be caused by forest fires and agricultural burning in Asia. Data from aircraft show that the plumes are made up of tiny particles of carbon averaging 300nm across. The plumes contained little propane or



tetrachloroethene (which would indicate an industrial origin), lending support to forest-fire hypothesis. This would explain the increase in atmospheric haze over the last decade despite lower emissions from Russian factories. As a result of this pollution the Arctic is warming faster than any other area of the globe.

Smelters

Smelting in Russia is a highly polluting operation that disfigures the local environment. The Monchegorsk region, for example, home to the Severanickel plant, has been devastated by smelter emissions. Trees located about four kilometres from the smelter were killed by the persistent high levels of sulphur dioxide. Severanickel produced black nickel for the first time in February 1939, and one year later clean nickel. In 1982, there was a substantial expansion of the operation for processing ore material from Norilsk that made this company the largest manufacturer of clean nickel in the world. In January, 2003, a new plant for the manufacture of copper, with an annual capacity of 15,000t, was brought into operation using cheaper and cleaner modern technology.

Nuclear weapons testing

The Soviet Union carried out extensive testing of nuclear weapons on the Novaya Zemlya archipelago in the Barents Sea: a total of 130 tests from 1955 to 1990 at latitudes between 71°N and 74°N. In all, the 224 explosive devices tested released about 265 megatons of explosive energy, including the Soviet Union's most powerful atmospheric bomb and their most powerful underground nuclear tests. These two tests had magnitude 6.97 and 6.98 and the total yield was 4.2mt. One of them created four small ridges and uplifted a region 120m across by two to three metres. The other resulted in an 80 million cubic metre landslide and a two-kilometre long lake behind the debris.



Conclusion

Arctic Russia plays a key role in the Russian economy. It is particularly noted for its mineral wealth but also plays a key role in shipping. There is no doubt that these roles are bound to increase as a result of global warming. 

Further reading

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 E: g.p.glasby@talk21.com; woyt@geoksc.apatity.ru

Society Business



Awards 2011

Nominations for Society Awards 2011, which will be presented at President's Day next year, should be submitted to the Awards Committee to arrive no later than **Friday 8 October 2010**.

Fellows wishing to nominate persons for an Award should go to www.geolsoc.org.uk/awards and follow instructions.

Edmund Nickless

Future meetings

OGMs:

29 September 2010;
24 November 2010;
3 February 2011;
13 April 2011.

Council:

29 September 2010;
24 November 2010;
2/3 February 2011;
(residential);
13 April 2011.

New Regulations

Edmund Nickless, Executive Secretary, writes: In accordance with the authority given to it in Bye-law 6.22, Council approved a comprehensive set of new Regulations at its meeting on 16 June 2010. This revision includes a change to the Grievance Procedures which have now been divided into appeals and discipline.

The new Regulations can be viewed on the website at www.geolsoc.org.uk/regulations and hard copies are also available for inspection in the Library.

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

When you renew, use Direct Debit!

Sharon McIntyre, Fellowship Services Manager, writes: As the AGM comes and goes for another year, it will soon be time for you to make arrangements for your renewal.

Although the payment date (November 1) may seem far away, invoices will be soon dropping on your doormat. Direct Debit is by far the simplest way, both of renewing your Fellowship and ensuring that you continue to belong to the professional body for Earth scientists. Chartered Geologists in particular can be assured that their status will be maintained uninterrupted by an inadvertent failure to pay. Direct Debit also allows you to spread the cost of Fellowship over the year - in this economic climate, an added benefit.

What's more, you can now do all this online. Online payment has been a resounding success and when renewing we encourage all Fellows who have yet to log in to the Fellows area of the website to do so, and see for themselves how simple the process is.

The benefits flow both ways. Processing cheques and credit cards places a heavy burden on the Society's resources. Direct Debit and online payment release staff time - which we can then devote to delivering core Fellowship services. As banks will be phasing out cheques in the near future, why not make 2010 the year you change to quick and easy payment by Direct Debit? 





Shell London Lecture Series

The remainder of the programme for the 2010 Shell London lectures is listed below. Entry to lectures is free and open to all, but by ticket only. To obtain a ticket please contact the Conference Office using the contact details below. Tickets will be allocated on a monthly ballot basis and we will not be taking indications of interest months in advance, so if you would like to attend any of the talks, please email us to let us to be added to the mailing list, or let us know around three or four weeks in advance of the talk date that you would like to attend. Most talks will be given twice on the same day, once at 3pm and once at 6pm.

Each talk will appear online shortly after the talk has been given. To view the presentations please visit the individual talk's event page, accessed via www.geolsoc.org.uk/shelllondonlectures10

DATE	SPEAKER	TITLE
Weds 8 September	Marie Edmonds (Cambridge University)	A lot of hot air: Degassing and volcanic eruptions
Weds 13 October	Jay Melosh (Purdue University)	Impacts
Weds 10 November	Rob Kleibergen (Shell)	Half empty or half full: How much oil and gas can we recover from our fields?
Weds 8 December	Martin Culshaw	Geological hazards: How safe is Britain?

Further information

To be added to the mailing list, or to request a ticket, please contact the Conference Office at the Geological Society.

To view abstracts and biographies, and to view films of past talks, please visit our website. T: +44 (0) 20 7432 0981;

E: events@geolsoc.org.uk W: www.geolsoc.org.uk/shelllondonlectures10.

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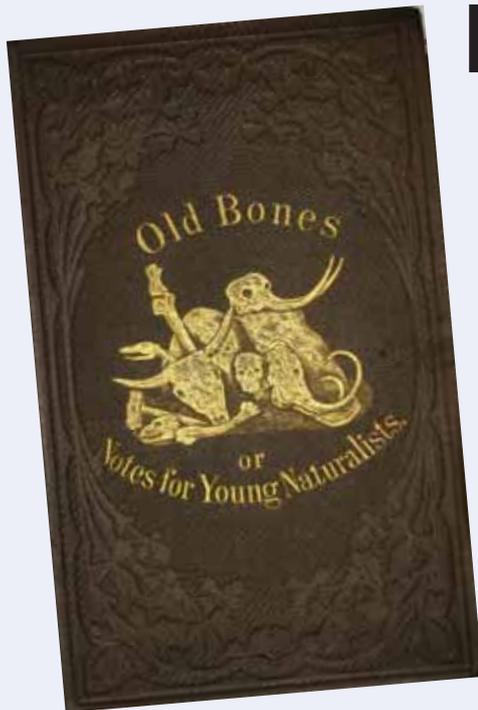




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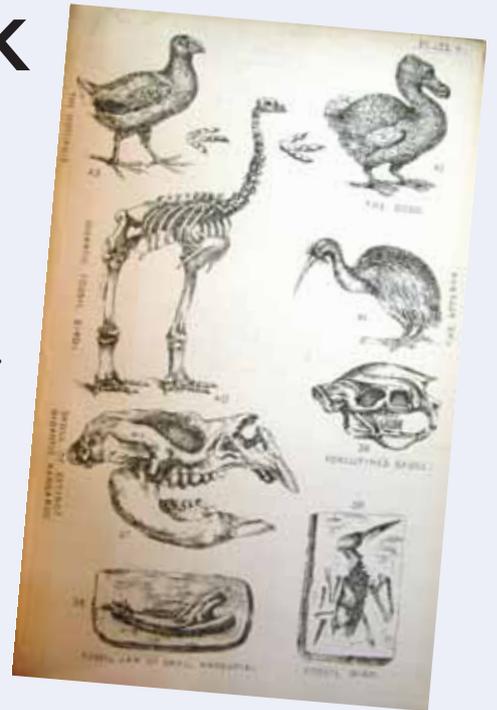
For a list of **new acquisitions** click the appropriate link from <http://www.geolsoc.org.uk/gsl/info>

The library is open to visitors **Monday-Friday 0930-1730.**



Rare book of the month!

Old Bones, or, Notes for Young Naturalists, on vertebrate animals, their fossil predecessors and allies by W S Symonds (1864)



The children's educational textbook has a long history. Arguably originating as far back as Ancient Greece, it proliferated with the invention of the printing press, and became widespread in the 19th Century through compulsory education in Europe. Though aimed at the older student, W S Symonds's *Old Bones, or, Notes for Young Naturalists* (1864), is an early example of a geological textbook, complete with numerous drawings, and divided into easily digestible and often entertaining chapters on Mammals, Birds, Reptiles and Fishes.

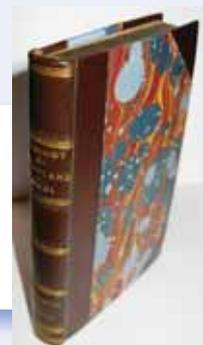
The book also has an interesting angle on educational pursuits as best removed from the classroom; in its preface, Symonds writes: 'I publish it in the hope that it may prove

useful to the Student, when he has the opportunity of visiting any of our various Museums or Zoological gardens, as I believe that the knowledge acquired from books becomes far more practical when impressed upon the mind by a careful examination of the works of Nature'.

Symonds (1818-1887), who also wrote a companion volume, *Old Stones* (1880), was an admirable early advocate of engaging young people in geology, a tradition continued by such titles as *Every Boy's Book of Geology* (1920), part of that popular series, and *Solving Earth's Mysteries, or, Geology for boys and girls* (1946), both also held in the Society's collection. 



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.



Virtual 'Help yourself box'

The Library has a selection of journal issues which are not required due to duplication, defect or damage. A list of these can be found on our website in the section on Library Collections - Serials, under the heading 'Surplus Journals' www.geolsoc.org.uk/gsl/info/collections/serial/page3358.htm.

Here you will find information on how to request them. They are available to both individuals and libraries. Please note that there may be a charge depending on the type of material and the weight, if posted.

Document delivery

Don't forget that the Geological Society Library can usually supply photocopies more cheaply than other providers e.g. British Library & the publishers. Remember - our journals have been bought with your money, and are here to be used!

Electronic copies

The Library is now able to arrange the supply copies of papers by Secure Electronic Delivery (SED) direct to your PC, if preferred to standard photocopies. The cost of this service via the Society's Library is £8.50 + title-specific copyright fee (if applicable) and VAT. For more information and to check whether you can receive documents in this way visit <http://www.bl.uk/sed>.

Copies ordered personally via BL Direct will automatically incur the copyright fee, regardless of whether the copy is required for private study/non-commercial research rather than for commercial purposes.

The Geological Society Library continues to offer a photocopying service to its members, charging 25p per A4 page or 30p per A3 page plus a handling charge and VAT. A standard copyright fee of £7.66 +VAT is added to each 'commercial research' request. Further details of the service, its charges and appropriate forms can be obtained by contacting the Library or looking on the Website.

Postal Loans

We use Royal Mail's Special Delivery to send all loans to borrowers, in order to guarantee next-day delivery and more particularly, so that the packages are insured in case of loss. Many books are now very expensive and if lost are difficult to replace. Please will borrowers ensure that all loans are returned to the Library by this means, or by a reputable courier who can guarantee the same protection.

WiFi access

WiFi (wireless fidelity) access to the Internet is now available to all readers. If you are visiting the Library and have a WiFi-enabled laptop you can ask the staff for a password to give you free Internet access.

Pick of the crop

To see what other books, maps & serials the Library has acquired, why not register to receive a copy of Recent additions to the Geological Society Library, either by post or email? Contact Wendy Cawthorne on wendy.cawthorne@geolsoc.org.uk.



Gift

Peter Friend has presented a copy of his book *Southern England: looking at the natural landscape* (The new naturalist library; 108), on the occasion of President's Day (June 2010), on which occasion he was awarded the Prestwich Medal.



Searching for FACTS?

**Don't just rely on the Internet!
Remember GeoRef and
Petroleum Abstracts are
available in your Library.**

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Affiliates.**

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The Geological Society



Unconventional Resources have Unconventional Reporting: True or False?

Wednesday 15th September 2010, 6.30 - 9.30pm
The Geological Society, Burlington House, Piccadilly, London



Three presentations will offer differing perspectives on the assessment of unconventional resources.

SPEAKERS

The Investor - Paul Wheeler, Bank of America Merrill Lynch
The Independent Auditor - Paul Chernik, ERC
The Operator - Dave Decker, BG

The event will start at 6pm with tea & coffee on arrival with the first talk starting at 6.30pm. The talks will be followed by a panel discussion and refreshments in the Lower library.

REGISTRATION

£25 GSL Fellows / SPE & SPEE Members
£35 Non Fellows

For further information and to register, please contact:

Steve Whalley, Events Co-ordinator: +44 (0)20 7432 0980

steve.whalley@geolsoc.org.uk or visit our website www.geolsoc.org.uk



Convenors:

Bernie Vining
(Baker Hughes)

Duncan Wade
(Equipoise Solutions)



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Ideally you'll have a Masters level qualification in Geosciences or Carbon Capture and Storage and will be able to demonstrate a broad range of technical and project management skills, gained through experience in a subsurface environment.

The person we seek is as unique as the role. ScottishPower is investing heavily in Carbon Capture and Storage and the successful applicant will play a pivotal role in helping shape our business in the years to come.

To find out more or to apply, please visit
www.scottishpower.jobs and search our vacancies page for IRC12315.

Closing date 31st August 2010.



FOUNDERS' DAY LECTURE AND DINNER

Thursday 11 November 2010

Tickets are limited

FROM PAVILAND TO PAKEFIELD:
700,000 YEARS OF HOMO BRITANNICUS

SPEAKER:
Chris Stringer
Natural History Museum

The search for human origins has always been, and continues to be, fraught with issues of identity, race, religion and nationality. This, combined with a palaeontological record that is extremely fragmentary and difficult to interpret, makes palaeoanthropology one of the most hotly debated issues in science. Professor Chris Stringer will trace our attempts to make sense of the origins of Homo britannicus, from Dean Bucklands "Red Lady" to the present day.



And afterwards at
Le Meridien, Piccadilly

Dress: Black Tie

Ticket price: £70

After dinner speaker, Dick Selley
(Imperial College, London)

Dining with dinosaurs



CONTACT DETAILS

For further details contact: Georgina Worrall, The Geological Society, Burlington House, Piccadilly, London, W1J 0BG
Tel: 020 7432 0983 Email: georgina.worrall@geolsoc.org.uk Web: www.geolsoc.org.uk/founders10

WILLIAM SMITH 2010

Landscapes into Rock

21 – 23 September 2010

The aim of this meeting is to bring together geoscientists from different sub-disciplines to address the problem of the interactions between erosional and depositional landscapes, sediment routing systems and the building of stratigraphy. By studying these interactions we gain a better understanding of the dynamics of the coupling between exhumation, erosion, transport and deposition of sediment in source to sink systems, and an enhanced ability to invert stratigraphy for forcing mechanisms.

CONVENERS

Philip Allen
Imperial College London
Hugh Sinclair
Edinburgh University
Paul Bishop
Glasgow University
Robert Gawthorpe
Manchester University

CONFERENCE THEMES:

THE EROSIONAL ENGINE

CONVENORS: Alex Whittaker (Imperial College London) and Andy Carter (Birkbeck College, University of London)
KEYNOTE SPEAKERS: Kelin Whipple (Arizona State University), Niels Hovius (Cambridge University)

THE DYNAMICS OF SEDIMENT ROUTING SYSTEMS

CONVENORS: Alex Densmore (Durham University) and Ruth Robinson (St. Andrew's University)
KEYNOTE SPEAKERS: Jim Syvitski (University of Colorado-Boulder), Chris Paola (University of Minnesota)

LANDSCAPES INTO ROCK: THE MAKING OF STRATIGRAPHY

CONVENORS: Sébastien Castelltort (ETH-Zürich) and Emma Finch (Manchester University)
KEYNOTE SPEAKERS: Mike Leeder (University of East Anglia) William Smith Lecture 2010, Rudy Slingerland (Pennsylvania State University)

INTEGRATIVE STUDIES OF SEDIMENT ROUTING AND THE PETROLEUM SYSTEM

CONVENORS: Ian Lunt (Statoil) and Mike Blum (ExxonMobil)
KEYNOTE SPEAKERS: Ole J. Martinsen (Statoil), Peter Burgess (Shell)



Leila Taleb, Event Co-ordinator

The Geological Society, Burlington House, Piccadilly, London, W1J 0BG.
Tel: 020 7432 0981 Email: leila.taleb@geolsoc.org.uk



PAST CARBON ISOTOPIC EVENTS AND FUTURE ECOLOGIES:

PALAEOANALOGUE CIEs AND CURRENT BIOSPHERE & ECOLOGICAL CHANGE AS GUIDES TO THE 22ND CENTURY AND BEYOND



2nd and 3rd November 2010
The Geological Society, Burlington House

The biosphere and many of its ecosystems are currently changing due to global warming in a manner unprecedented for many million years. Research shows that abrupt environmental perturbations of the late Palaeocene to early Eocene some 55 million years ago, and also of some earlier periods, might be used as biospheric and ecological palaeoanalogues for present-day and future global change.

This two-day discussion meeting sees invited presentations from internationally renowned geoscientists and ecologists in environmental and palaeoenvironmental change. The meeting will bring together scientists and policymakers from a range of disciplines to explore how current geological and ecological synergies illuminate our understanding of what planet Earth might be like 100 years or more in the future.

CONVENORS:

Jonathan Cowie
Concatenation Science Communication:
science-com.concatenation.org
Dr Anthony Cohen
The Open University

INVITED SPEAKERS INCLUDE:

Dr Manuel Ramage
Plymouth Marine Laboratory
Dr Peter Mayhew
University of York
Dr Andy Ridgwell
University of Bristol
Professor Jim Zachos
University of California, Santa Cruz



FOR FURTHER INFORMATION CONTACT: Georgina Worrall, Tel: +44 (0)20 7432 0983
Email: georgina.worrall@geolsoc.org.uk or visit our website: www.geolsoc.org.uk/events



The Geological Society

The Geological Society CAREERS DAY 2010



Wednesday 10 November 2010
East Midlands Conference Centre, Nottingham

Careers Day is for geosciences undergraduates and postgraduates to find out about the latest career developments and opportunities.

The day will run from 10am - 3.30pm followed by a beer reception, and will include presentations and an exhibition fair.

REGISTRATION

There is a £10 registration fee to attend this event. This fee covers all delegate material, refreshments, lunch and a beer at the reception. Alternatively bring your own refreshments and lunch and registration is free of charge.

For further information and to register your attendance, please contact Leila Taleb:
Email: leila.taleb@geolsoc.org.uk Tel: 020 7434 9944 Website: www.geolsoc.org.uk/events



servicing science and profession



Continuing Professional Development (CPD) Courses

• **10-12 August** *Whittle Foundation Course*. Venue: Coalville. The Whittle Foundation course is a comprehensive three-day course designed for geologists and mine engineers who are responsible for pit optimisation. Fellows of the Society will receive a 15% discount, please mention this when registering. **Contact:** Gemcom T: +44 (0) 1530 835554 E: sales-eu@gemcomsoftware.com W: www.gemcomsoftware.com

• **7-9 September** *Surpac Foundation Solids & Block Modelling Workshop*. Venue: Coalville. The Surpac Foundation, Solids & Block Workshop is an amalgamation of both the Foundation course and the Solids and Block Modelling workshops. It is a comprehensive 3 day workshop designed for new users of Surpac and will aid in solidifying the users' knowledge of Surpac's solids modelling capabilities. The course will also examine in details the steps necessary for Block Modelling in Surpac. GSL Members receive a 15% discount, please mention this when registering. **Contact:** Gemcom T: +44 (0) 1530 835554 E: sales-eu@gemcomsoftware.com W: www.gemcomsoftware.com

• **8 September** *Groundwater Sampling*. Venue: Birmingham. The requirements of the Water Framework Directive have given a new emphasis to the need for groundwater quality monitoring, and for obtaining reliable and reproducible data. This workshop will help to broaden your understanding and gain a hands-on appreciation of the range of equipment now available for different sampling methods, including 3 well volume purging, low flow (or "micro-purge") and passive sampling. It will also familiarise you with up to date R&D including the concept of flow-weighted averaging and the problems associated with mixing in boreholes. **Contact:** Julie Rose T: 0121 733 3533 E: Julie.rose@waterrauk.com W: www.waterrauk.com/Pages/general/training.asp

• **8-11 September** *Extractive Industry Geology Conference 2010*. Venue: Portsmouth. The Extractive Industry Geology 2010 conference will be held at the School of Earth and Environmental Sciences at the University of Portsmouth. This event is for geo-professionals associated with the industrial extraction of rocks and minerals, including those involved in geology, hydrogeology, geotechnical engineering, restoration and after-use, reserves and resources and quarry design and planning. The conference includes two days of presentations, plus pre- and post-conference field trips. **Contact:** Mark Pritchard (EIG Secretary) T: +44 (0)1608 819330 E: MarkP@pgwassoc.co.uk W: www.eigconference.org

Developing Geological Knowledge for CGeol Status, First Steps Ltd. For reservations and information **contact** Christine Butenuth, info@firststeps.uk.com, 0207 589 7394, www.firststeps.eu.com.

Managing Performance through People, The Open University. Online Course. **Contact** David Robinson, d.t.robinson@open.ac.uk, 0870 900 9577, www.open.ac.uk.

Effective Leadership Skills, The Open University. Online Course. **Contact** David Robinson, d.t.robinson@open.ac.uk, 0870 900 9577, www.open.ac.uk.

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AUGUST

South West Regional

• **11 August** *Visit to Beer Quarry Caves with in-depth special interest guided tour (90 mins)*. Venue: Beer Caves. A complex of underground caverns, created by centuries of quarrying the famous Beer Stone, this underground quarry, first worked by the Romans, supplied stone for 24 cathedrals, the Tower of London, Hampton Court and Windsor Castle. Quarried by hand, the smallest blocks weighing four tons, the stone was carted on horse-drawn wagons and by barges from Beer beach to its destination - sometimes involving journeys of several hundreds of miles. Beer stone was much prized by masons as, freshly quarried, it is ideal for fine carving. Cost: £6.00 adult; £4.25 senior citizen; 6.15pm start at caves. **Contact:** Cathy Smith E: swrg@geolsoc.org.uk

SEPTEMBER

Geoscience Information Group

• **6-7 September** *Data Management Workshop and Knowledge Exchange* Venue: Dynamic Earth, Edinburgh. A unique two-day international forum and knowledge exchange organised by the PESGB and the Geological Society, featuring a range of interactive workshops, knowledge cafes, and practical demonstrations reviewing case histories, lessons learnt and examples of best-practice in the energy sector. **Contact:** Duncan McKay E: duncan.mckay@conocophillips.com



• **6 September** *LoPro: The Value of Low Yield Aquifers*. Venue: University of Edinburgh. Low yield aquifers, also known as low productivity aquifers, are of great importance in large parts of the world, particularly with respect to supporting local water supply as well as providing baseflow to surface waters and wetlands. **Contact:** Isla Small E: isla.small@sepa.org.uk Brighid O Dochartaigh E: beod@bgs.ac.uk



• **8 September** *A Lot of Hot Air: Degassing and Volcanic Eruptions*. Venue: Burlington House. A Shell London Lecture. Speaker - Marie Edmonds, University of Cambridge. The exsolution of gases lowers magma density during its ascent through the crust and influences buoyancy as well as its rheological properties. How fast the magma ascends, the formation of bubbles and how efficiently the melt and gas can segregate from one another in the volcanic conduit largely determines the style of the volcanic eruption at the surface. This lecture will examine the process of magma degassing and volcanic eruptions using observations from large scales using satellite-based instruments, down to the microscopic scale using observations of crystals and melt in the erupted rocks. **Contact:** Leila Taleb T: 020 7432 0981 F: 020 7494 0579 E: leila.taleb@geolsoc.org.uk.

South West Regional

• **15 September** *Guided walk of the Building Stones around the centre of Exeter with Mike Barr* Venue: Exeter City Centre. Meet at 6:30pm outside Cathedral - limited numbers so booking is required. Approximately 60 minutes, with pub finish for those so inclined! For booking **contact:** Cathy Smith E: swrg@geolsoc.org.uk



• **15 September** *Unconventional Resources Evening Lecture*. Venue: Burlington House. Co-organised by SPE and SPEE. Three presentations will offer differing perspectives on the assessment of unconventional resources. Speakers: The Investor - Paul Wheeler, Bank of America, Merrill Lynch; The Independent Auditor - Paul Chernik, ERC; The Operator - Dave Decker, BG. The event will start at 6pm with tea & coffee on arrival with the first talk starting at 6.30pm. The talks will be followed by a panel discussion and refreshments in the Lower Library. **Contact:** Steve Whalley E: steve.whalley@geolsoc.org.uk F: 020 7494 0579

East Anglia Regional

• **21 September** *Monitored Natural Attenuation in Fractured Chalk*. Venue: he Maltings, Ship Lane, Ely, CB7 4BB, Ely. Speaker: Dr Rachel Dewhurst. Time: 1900. Monitored Natural Attenuation (MNA) is increasingly becoming an accepted remedial technology for sites where engineered remediation solutions are not practicable or cost-effective. However, when applying the Environment Agency's guidance on the assessment and monitoring of natural attenuation of contaminants in dual porosity aquifers, it can be difficult to obtain the appropriate evidence to prove that natural attenuation is occurring. Using data from RAF Mildenhall and two other case studies in the Chalk, the issues with obtaining good evidence of natural attenuation will be discussed. **Contact:** Sarah Thomson T: 07843 202249 E: Sarah.Thomson@uk.mwhglobal.com.



• **21-23 September** *William Smith Meeting 2010 - Landscapes Into Rock* Venue: Burlington House. The aim of this meeting is to bring together geoscientists from different sub-disciplines to address the problem of the interactions between erosional and depositional landscapes, sediment routing systems and the building of stratigraphy. By studying these interactions we gain a better understanding of the dynamics of the coupling between exhumation, erosion, transport and deposition of sediment in source to sink systems, and an enhanced ability to invert stratigraphy for forcing mechanisms. **Contact:** Leila Taleb T: 020 7432 0981 F: 020 7494 0579 E: leila.taleb@geolsoc.org.uk.



• **28-29 September** *Nuclear Waste Management: Research Challenges for the Future (2010)* Venue: Fitzwilliam College, Cambridge. This conference will address key questions for the next generation of nuclear waste researchers. What are the emerging research priorities, and what progress is being made? How are those in historically distinct disciplines to work together to address new challenges? What skills are required for research and delivery of a geological disposal programme, and how can funding and implementation bodies be configured to encourage talented scientists to build long-term careers in this area? Please visit the website for registration details. **Contact:** Kevin Murphy E: kevin@minersoc.org

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The Geological Society



International Conference:

The Geology of Unconventional Gas Plays

4 - 7 October 2010

The Geological Society, Burlington House, Piccadilly, London

REGISTRATION NOW OPEN

It is generally recognised that unconventional gas resources will make up a major part of our future energy needs. In recent years there has been a marked increase in interest in these resources from industry and especially amongst the major western oil and gas companies. Many of the technical issues surrounding unconventional gas plays revolve around the complex engineering solutions required to commercially exploit them. The aim of this conference however is to specifically address the geoscience issues related to their exploration and exploitation.

We invite oral and poster presentations on the following themes:

- **Overviews of Unconventional Gas Plays**
- **Shale Gas**
- **Tight Gas Reservoirs**
- **Coalbed Methane**
- **Gas Hydrates**

Within each theme we welcome contributions that address any relevant geoscience issue, such as petroleum system analysis, reservoir geology, geophysical evaluation, structural geology and fracture prediction as well as case studies on particular plays, basins or fields.

We aim to bring together key figures in industry and academia active in both established unconventional gas plays of North America and emerging plays of Europe, plus other plays around the globe.

The following speakers have agreed to deliver keynote talks:

- **Richard Chuchla (ExxonMobil) - Unconventional Gas Resources: An Integrated Global Perspective**
- **Ken Chew (IHS & Morenish Mews, UK) - European Unconventional Gas Plays**
- **Prof. Terry Engelder (Penn. State Univ.) - Shale Gas**
- **Prof. Dan Jarvie (Texas C.U./IFP) - Shale Gas**
- **Prof. Brian Horsfield (GFZ Potsdam) - Shale Gas**
- **Steve Cumella (Bill Barrett Corp.) - Tight Gas Sandstones**
- **Andrew Scott (Consultant) - Coal Bed Methane**
- **Tim Collett (USGS) - Gas Hydrates**
- **Prof. Graham Westbrook (Univ. Birmingham) - Gas Hydrates**

Please send all abstracts and sponsorship enquires to Paul Doubleday at doubled@statoil.com

For further information about this conference, please contact:

Steve Whalley, Event Co-ordinator: +44 (0)20 7432 0980

or email: steve.whalley@geolsoc.org.uk

Convenors:

Paul Doubleday
(Statoil)

Stephen Laubach
(The University of Texas)

Lois Atterton
(Statoil)

Jaquie Bond
(ExxonMobil)



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THE ROLE OF THE UK AND IRELAND IN GLOBAL MINERAL EXPLORATION

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Britain and Ireland have long played leading roles in stimulating and financing global metal mining and exploration world-wide. FINEX '10 will examine this pre-eminent status and provide a forum to exchange ideas and visions across the interface between the financial and mining sectors.

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