The magazine of THE GEOLOGICAL SOCIETY OF LONDON

Geoscientist

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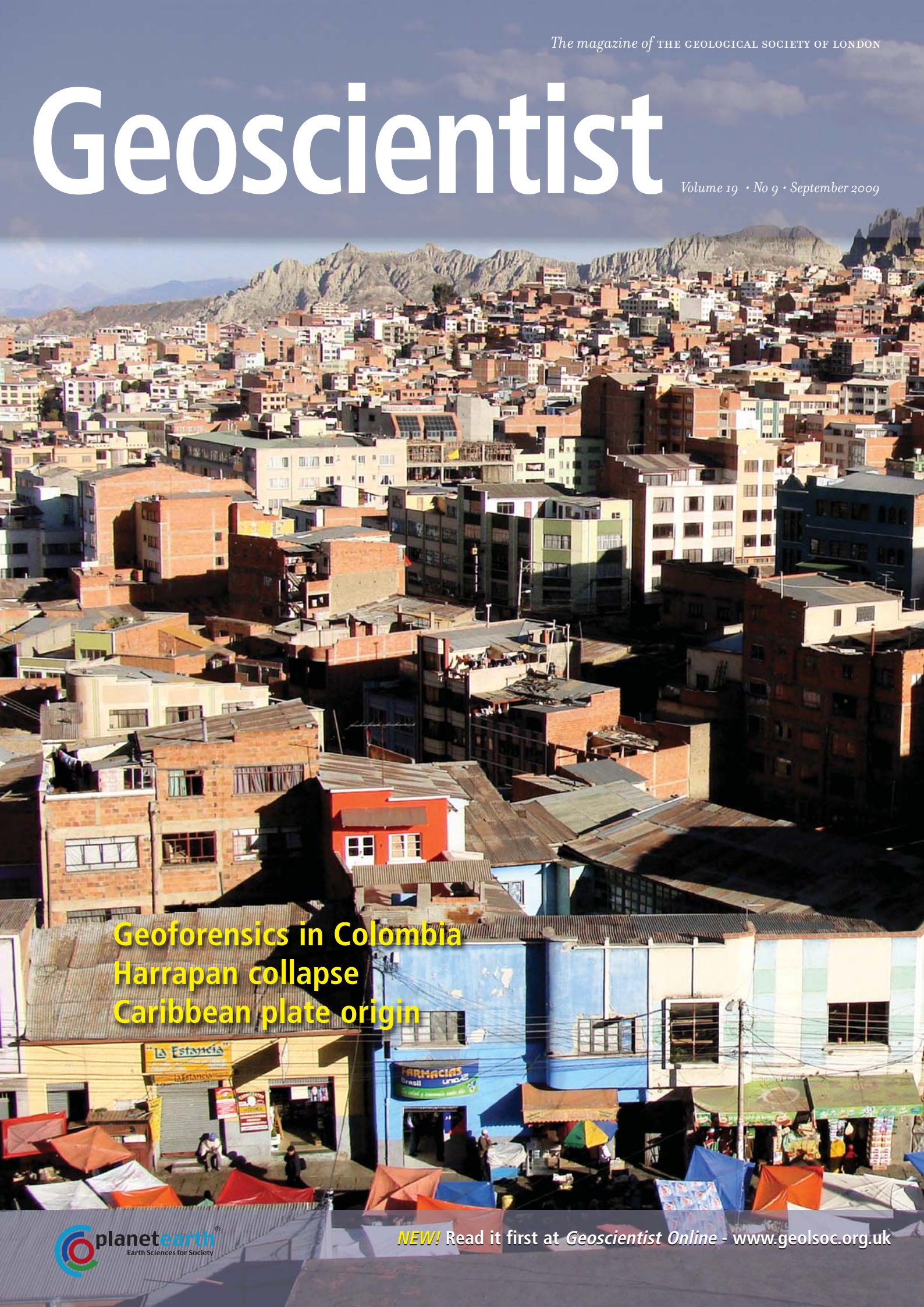

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Not arguing with the REF

Ted Nield applauds a recent announcement by Lord Drayson.

The Association of British Science Writers (ABSW), the UK professional organisation for science writers is, like the Geological Society, the oldest of its kind in Europe (founded 1947), and your Editor has served as its Chair for the past three years (yes, *three* – GSL presidents have it easy).

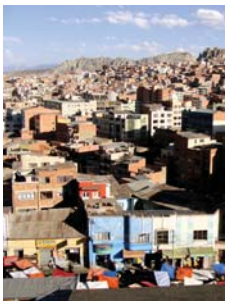
Being a firm believer in quitting while ahead, I recently handed over to my successor, during my term of office's climactic event – the World Conference of Science Journalism 2009. That we succeeded in attracting 950 participants from 70 countries to London was wonderful. That the meeting should also have given rise to actual *news* was all the more marvellous for being so unexpected.

On its first full day, the Conference welcomed Lord Drayson, the Science Minister, who used the occasion to make an announcement. In the forthcoming Research Excellence Framework (REF), he said, scientists would be given points for communication. The Government, he said, was changing the way it judged researchers' performance because of the seriousness with which it took public engagement. "We believe that scientists have a duty – particularly when funded by taxpayers – to engage in communication of the challenges and the potential ethical concerns about their science, and that will be included in the REF" he told us.

Such a move is long overdue and should be applauded – as should the good Lord's mature attitude to the way science is covered by the media. During a debate in which he participated that same day, after asserting his belief that science coverage in the UK media was "the best in the world", Drayson said that a "period of reflection" had followed the bogus scaremongering stories that had blighted coverage of GM foods and the MMR vaccine.

He hit the nail on the head when he said "I believe the key is that science journalists are in charge of the story and not general journalists". This was music to the ears of SJs, who often must look on in impotent despair as science–based stories escape from their grasp, vanish into the maw of general news and come out horribly mangled. Drayson also recognised that "sensational" reporting was a necessity, and not necessarily an evil - as long as the science was correct, of course.

One of the great attractions of science as a beat is that it is so often about "good" news. It is, by its nature, often sensational. "Sensationalism" is usually used pejoratively, but is part and parcel of interesting the wider public in the fantastic things that science does. As Drayson concluded, "We need a society that is awestruck by science, not dumbstruck by it". Hear hear – and to make it so, we need scientists who are not dumbstruck before the media. Encouraging them, via the REF, to go out there and engage, can only assist the process. All eyes will now be on the Funding Councils. Bureaucracies have an uncanny knack of achieving in implementation precisely the opposite ends to those intended; so it will be interesting to see how (or indeed whether) they can implement this laudable initiative in imaginative and intelligent ways.



Front cover:
Bogota, Colombia. The country's complex crime history provides ample material for geoforensic investigation. See People Feature, p6.

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Editorial Team Editor-in-Chief: Professor Tony Harris, Editor: Dr Ted Nield, Features Editor: Dr Robin Cocks, Editorial Adviser: Dr Joe McCall Contributing Editor: Dr Sue Bowler, Reviews Editor: Dr Martin Degg, Council Representative: Dr Nick Rogers

Fellowship Queries The Geological Society, Burlington House, Piccadilly, London W1J 0BG Tel:+44 (0)20 7434 9944, Fax: +44 (0)20 7439 8975, Email: enquiries@geolsoc.org.uk, Society website: www.geolsoc.org.uk

Library Tel: +44 (0)20 7432 0999, Fax: +44 (0)20 7439 3470, Email: library@geolsoc.org.uk.

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Soapbox

Drag act

Sarah Day asks - why should a woman be more like a man?

This year is full of scientific anniversaries. From Darwin to Galileo to Kepler to Walcott, we have spent most of the year celebrating the achievements of some of the great men of science, and rightly so. But 2009 also marks a more recent anniversary – 25 years since the start of the WISE Campaign, to encourage more women into science and engineering fields.

When it comes to women's rights, science has had a rather less illustrious history. Just 107 years ago, for example, Hertha Ayrton, the Cambridge mathematician, was refused fellowship of the Royal Society since, as a married woman, she was not legally a 'person'. Things are very different now, but the fact that organisations like WISE still exist suggests there is more work to be done. Currently the Royal Society's female fellowship stands at just 5%.

As an optimistic person, this doesn't worry me as much as it will others. Things are changing rapidly, and as fellowship of the Royal tends to be a late career development, it's not surprising that its gender profile reflects the past. What I do find depressing is the popularity - among men and women alike - of the "Professor Higgins" approach: that to achieve equality women should "act more like men". It crops up in the business world too. Scientific studies have been carried out to find out what the benefits are for women of "behaving more like men" (whatever this means) in the workplace. The ever-flattering *Daily Mail* recently announced that by adopting a 'masculine approach', women could earn £40,000 a year more than 'nicer' female colleagues.

Of course, women can sometimes be aggressive and men can sometimes be softies. But can "equality" really be achieved by this sort of perverse drag-act? The solution surely lies in our attitudes to the subject, not to ourselves. Men have historically been more successful in areas like science and business, because it was largely men who invented them. The founding of our own Society, by 13 guys in a pub, is characteristic of the origins of science as we know it today, with learned societies and institutions having their roots in a world that didn't even allow women to own property, let alone carry out research.

One man in a million may shout a bit.
Now and then there's one with slight defects;
One, perhaps, whose truthfulness you doubt a bit.
But by and large we are a marvellous sex!

Alan Jay Lerner

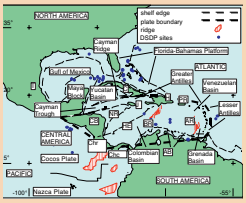
In the UK at least, that worldview is gone and our view of science should go with it. Like men and women, science can be many things. It can be logical, methodical, repetitive, boring. It can also be creative, inspiring, spontaneous, emotionally engaging. But for some reason, particularly at school, it is still regarded as a pretty one-dimensional affair. All the creativity, the passion, the excitement, is veiled in stereotypes.

Change this, and there would be no need for fruitless arguments about what attributes and qualities are typical of men and women. It might not mean the gender profile of Royal Society fellows will one day be an exact 50:50 split, but that doesn't matter. What matters is that in the future there should be no need for organisations like WISE, worthwhile as they are.

Here's hoping they don't need to reach their 50th.

Come on, folks: the staff shouldn't have to write the bits of the magazine that are designed for readers! We would like to leave that technique to the letters columns of *Playboy*. Something must be annoying someone out there, among our 10,000 fellows. Write it entertainingly in 500 words and this slot could be yours.

Contents



Carousel

Theo Davies has taken up the position of Professor of Environmental Geology with the Department of Mining and Environmental Geology at the University of Venda (www.univen.ac.za), Limpopo Province, South Africa. This rural -based Institution is surrounded by an ideal field laboratory in the form of the entire Limpopo Province, ideal for studies in the emerging field of medical geology, Theo's abiding interest. Theo, a former Council member, would like to inform all his friends and colleagues that his new address becomes : T.C. Davies, PhD, CGeol, FGS., Professor of Environmental Geology, Department of Mining and Environmental Geology, University of Venda for Science and Technology, Private Bag X5050, Thohoyandou 0950, Limpopo Province, Republic of South Africa Cell : +27-73-80-47-646.

Anthony Azubuike Elueze (University of Ibadan) has been made a Fellow of the Nigerian Mining and Geosciences Society and was elected its President from 2009, during the NMGS 45th Annual International Conference. His installation took place on Friday June 9, in the Trenchard Hall of the University of Ibadan. Prof. Elueze also received the NMGS Award for "Most Active Council Member" for 2008/09.

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

Correction

The April issue (*Geoscientist 19.4*) carried news of the Eni Challenge Award in a way that may have given the impression that the Award was made to Dr Liz Berry (Forest of Dean Historical Society) alone. The Cumberland Geological Society has asked *Geoscientist* to point out that the award was presented jointly to the FDHS and the Cumberland Geological Society, represented by Mervyn Dodd. We are happy to make this clear and to apologise for any embarrassment caused to either party. *Editor*

30 years before the mast

Dawne Riddle writes: Fellowship Secretary Janine Benn celebrates her 30th year on the Society staff this month. Says Jan: "I got the job after my mother rang. I left Southgate College after doing a secretarial course and worked for the British Oxygen Company computer services selling accounts packages." She stuck this for five weeks. "My mother knew I liked geography and geology so just looked in the telephone book for the Geographical Society - and found the Geological Society! She got through to the Library and Mrs Nutt (the late Edeltraud Rosa Nutt – former Chief Librarian, whom many Fellows will be unable to forget… *Ed.*) mentioned that the Society was looking for an administrative person."

As it happened, the mother of the deputy executive secretary, Mary Lewis, had worked at Southgate College, and so Jan got her interview. "I think it also appealed to the Society that, coming straight from college, I did not need a high salary and they didn't have to pay agency fees!" Jan began work on reception and switchboard, dealing with membership, book sales, room hire and doing secretarial work for the Executive Secretary, the late David Clayton. "The Royal Geographical Society also offered me a job" recalls Jan, "but the Society paid more! (a princely £3200pa)"

Cover caption

The July issue of the magazine (*Geoscientist 19.7* – cover) carried a charming photograph of Miss Lili Reynolds, studiously reading her copy of *Geoscientist*. We received several caption suggestions, many of which recalled the 1980s muppet prog, *Fraggle Rock*. However we would like to single out the following, by Dr Graham West of Wokingham, as our winner. We particularly admired its clever use of a minor detail, and the glancing insult it delivers to Young Earth Creationists.

"Moving continents? Evolution? 4567 million years? Dolly's never going to believe all this rubbish…"

Many thanks to all who sent in suggestions. *Ted Nield*

New Director for USGS

President Barack Obama has nominated California-based geophysicist Marcia McNutt, currently president and chief executive of the Monterey Bay Aquarium Research Institute (MBARI) as the next Director of the United States Geological Survey. McNutt will also become scientific adviser to the interior secretary. McNutt, described as "an avid horsewoman" is expected to take the reins following her Senate confirmation hearing this month.

DISTANT THUNDER

In the month that the British Science Association festival descends on the cathedral city of Guildford, Nina Morgan reflects on the religious divide…*

To hell in a hand basket

As the cathedral city of Guildford welcomes visitors to the annual British Science Association Festival this month, Nina Morgan discovers why the BA meeting in 1838 got one churchman very hot under his dog collar.

Since 1831 the annual meetings of the British Association for the Advancement of Science (BAAS, now re-branded as the "British Science Association" but emphatically NOT the BSA), have drawn together large numbers of scientists and interested members of the public to discuss and debate the full range of scientific ideas of the day. The privilege of hosting a meeting was often highly contested among cities keen to benefit from both the intellectual and commercial stimulus that the meeting would bring (see *Distant Thunder passim.*, Geoscientist 18.9, September 2008). But not everyone agreed that holding a BA meeting was a good thing.

Sir William Cockburn, Dean of York Minster, was so incensed at the prospect of holding the 1838 BA meeting in Newcastle that he published a scathing *'Remonstrance'* directed at the Duke of Northumberland, then president of the BAAS. In this pamphlet Cockburn warmed up by expressing his regret at the Duke's intention "to preside at the next meeting of peripatetic philosophers at Newcastle" before turning up the heat to argue that: "These annual assemblies of Thespian Orators, while they confer no benefit upon science, have been, and are likely to be, injurious to religion". Finally he burst into flames with the warning: "Let it be also especially remembered that there are among those who take a lead in such meetings, many persons ill-affected to Christianity, and who, like the Sadducees of old, to gain a little notoriety among their fellow-men, would give up all hope of hereafter".

Thankfully, attitudes have now changed. This year's British Science Festival, based at the University of Surrey within sight of Guildford Cathedral, will be covering the usual broad range of science topics. But just to show that these issues never quite go away, it will be including a *three and a half hour* discussion entitled *Science and Faith*. For those possessed of a lively mind and a philosophical bent, it should prove a heavenly occasion.

Acknowledgements

Thanks to Jay Bosanquet, who is writing a PhD in the History of Science at Durham University, for alerting me to this story and for providing background information about William Cockburn as well as copies of the relevant pages of Cockburn's Remonstrance.

* *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.

Deaths

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

The Society notes with sadness the passing of:

Baumer, A*
Bishop, Richard*
Cowan, Greig*
Johnson, George A L*
Mills, Anthony B*
McKinlay, Alex C M*
Truss, Stephen*

In the interests of recording its Fellows' work for posterity, the Society publishes obituaries online, and collects them once a year in its *Annual Review*. 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 (*).

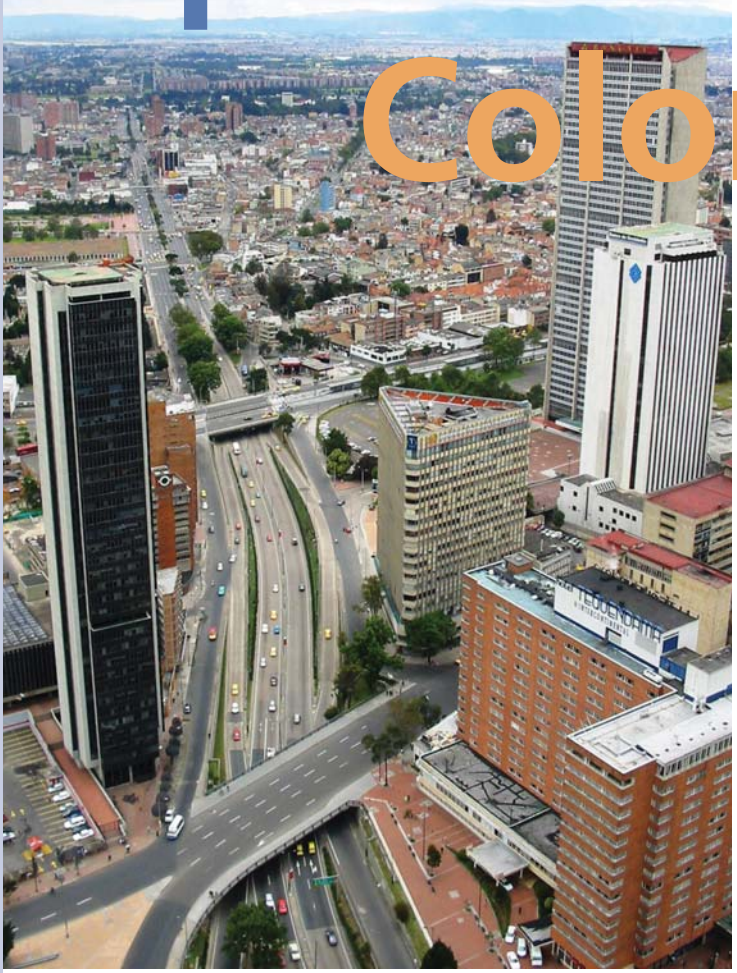
If you would like to contribute an obituary, please email ted.nield@geolsoc.org.uk to be commissioned. You will receive a guide for authors and a deadline for submission. You can also read the guidelines for authors at www.geolsoc.org.uk/obituaries. To save yourself unnecessary work, please do not write 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 in the next available *Annual Review*.

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.

Operation Colombia



Though terrain may differ, geoforensics knows no boundaries, as was demonstrated when UK and US geoscientists were invited to Colombia to help the fight against serious crime. Adler deWind reports.

Colombia, with a population of approximately 44 million, is a country that relatively few western geologists have visited. However, with careful planning, and in association with Colombian geologists and local logistical support, it is possible to visit Colombia safely and to participate in geological investigations - provided appropriate safety and security measures are taken.

In March this year, four geologists, two from the UK and two from the US, were invited to participate in the 'first Ibero-American course on forensic geology'. We visited the headquarters of both the Colombian Police and National Forensic Crime Laboratories (*Instituto Nacional De Medicina Legal y Ciencias Forenses*) to give advice on those geological methods and techniques that may be used either to locate buried objects (such as homicide graves, mass genocide graves, firearms, explosive devices and drugs) or analyse rocks and soils so as to provide physical evidence that may link suspect or offender with a crime victim.

Colombian geoscientists are fast emerging as world-class geoforensic specialists and join a global trend, over the past few years, for geoscientists to be called in to support police and law enforcement agencies. In Colombia, with its long and complex crime legacy, there is a great need to bring those responsible for historical, recent and current crimes to justice. It is also desirable for graves and mass graves to be located so that family members can bring some closure to their suffering. Furthermore, buried explosive devices, weapons, firearms and illegal drugs require to be located, so as to hinder criminal activities by depriving them of resources.

The first Ibero-American course on forensic geology was organised by Dr Carlos Martín Molina Gallego and was held at the National University of Colombia's Department of Geology, together with Colombia's National Institute of Medical, Legal and Forensic Science from 30 March to 3 April, in Bogota. The course highlighted the significance and applications of geology to prosecutors, judges, lawyers, forensic scientists and the Colombian judicial police penal system.

Dr Laurance Donnelly, founder and chair of The Geological Society of London Forensic

Geoscience Group, provided a series of lectures on: the importance of the development of a conceptual geological model to locate a homicide graves and buried objects, the development of search methodology, determination of search assets and techniques, the importance of effective communication between the police and geologists, regulation and accreditation, training needs for both police officers and forensic geoscientists, police protocols at crime scenes and case studies in geoforensics.

Other leading experts included US forensic geologists Dr Raymond Murray and Mr Bill Schneck, and Dr Alastair Ruffell, a geophysicist from Queens University, Belfast.

Dr Donnelly, Dr Murray (Missolua, Montana) and Dr Molina visited the Colombian Police at their Bogota HQ to gain a greater understanding of some of the challenges routinely facing Colombian police. This included addressing approximately 100 officers, and an inspection of the crime laboratories - where countless seized explosive devices, firearms and drugs are held. Some of the more recent anti-personnel mines are made from plastics, which make their detection more difficult. Colombian police officers face major challenges: including disarming criminal organisations, combating illegal trafficking of drugs across Colombia's borders, and of firearms and weapons into Colombia (often in exchange). In addition, anti-personnel landmines and other explosive devices make some parts of Colombia too dangerous to visit - let alone undertake geological surveys. Furthermore, many of the homicide victims of Colombia's violent past have been placed in unmarked graves, and many locations are suspected as locations of mass graves - the result of genocide.

Mr Schneck (Microvision Northwest-Forensic Consulting, Inc. and the Washington State Patrol Crime Laboratory, USA) and Dr Ruffell (Queens University Belfast) visited the *'Instituto Nacional de Medicina Legal'* which is effectively Bogota's forensic laboratory. Here, in touring its seven floors of labs, and seeing the view from the seventh floor (which gave a good feel for the layout of Bogota at the foot of the Andean mountain belt) they were left with a strong sense of the size of the problem that is being tackled.

How can geologists be of assistance? Laurance Donnelly explained: "Traditional police methods of finding graves often involves large-scale gridded areas with personnel 'finger-tip/line searches' and 'trial-and-error' excavations. These may be inefficient, cost prohibiting, often non-productive, labour intensive, may destroy evidence and ignore subtle ground disturbances. The search for a homicide victim's grave is one for, rather than of, the crime scene. The aim is to progress the investigation by locating the victim using an offensive/detective search procedure. The objectives would be to obtain evidence for a prosecution, gaining further intelligence, and locating the remains of the victim. The search does not have the objective of the recovery of evidence or the victim."

A conceptual geological model provides estimates of the target's age; size and geometry; expected depth of burial; time and duration of burial; and physical, chemical, hydrogeological and geotechnical variations compared to the surrounding ground. A conceptual model of a potential burial site gives an estimate of what is likely to be found, and the condition of the target. Conceptual geological models are developed at the beginning of a search. It is a model to be tested, revised and tested again until it can be verified (at discovery) or proven otherwise and therefore abandoned. What is more, this model, developed originally by Dr Donnelly to search for graves in the UK, is applicable throughout the world.

The development of a geological model for a victim of homicide, or a grave, requires a specific understanding of the natural (geological) ground conditions and how these have been influenced by the activities of the offender such as, for example, digging and subsequent reinstatement of the disturbed ground. At any one location there are likely to be a number of interactive, dynamic, active surface geological processes, which have affected the rocks, soil, groundwater and topography. These processes were active long before burial took place and are likely to have continued in the time that has elapsed since the burial.

It is vital to acquire an understanding of the undisturbed (pre burial) and disturbed (post burial) geology and the target (no matter whether that target be drugs, firearms, human remains, explosives or money). Only then can investigators decide the correct search strategy, including choice of instrumentation, or identify the optimum method of deployment. Techniques may include geophysics, geochemistry, satellite imagery, air photo interpretation and invasive methods (such as auguring, drilling, trial pitting and trenching). Geological investigative techniques are applicable to law enforcement searches because their underlying search philosophy, concepts and principles are similar – i.e., there is a buried/concealed 'object' or 'target' desirable to be found.

"The most important services that a forensic geologist can give the police and a law enforcement search strategist are: the production of a geological model of a potential grave or burial site; an understanding of the geological and geomorphological processes; the characterisation and understanding of the origin, source and properties of the soils, rocks and target (body); and a choice of detecting methods" says Donnelly.

No single geological model suits all types of search areas and there is no single approach to producing a geological model, as each homicide case and search area will have unique characteristics. This is one of the primary roles for the geoscientist, which will vary from case to case. Geologists should not act alone when searching for grave or other buried objects, but form part of a multidisciplinary team of specialists.

"Geoscientists must recognise how their expertise and capabilities fit into the broader homicide investigation. For geoscientists involved in searching for victims of homicide, for example, their input may reduce once the target has been located, and the investigation moves into victim recovery and crime scene investigation. It is then important to hand over to other forensic practitioners in related sciences, such as forensic archaeology and anthropology, for victim recovery and post recovery analysis."

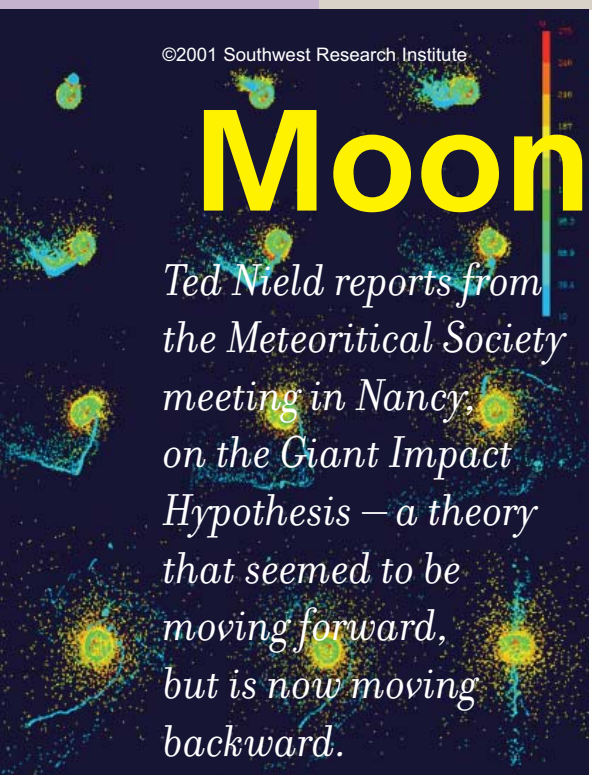
Clearly, effective communication is crucial along with an understanding of other specialists' skills and their limitations. Also important, for the forensic geoscientist, are the strict police protocols for the investigation of crime scenes and an appreciation of the judicial systems, unique to each country.

A meeting with the directors of the *Instituto Nacional de Medicina Legal* will form the basis of further collaboration, including exchanges of scientists between Colombia, the UK, USA and other countries now participating in the global network of contacts developed by The Geological Society of London Forensic Geoscience Group.

"There is now a growing network of geoforensic specialists in academia, industry, consultancy, police, law enforcement and the military throughout the world. The success of the first Ibero-American course on forensic geology has brought Latin America into the global association of geoforensics" says Donnelly.

The next major geoforensic conference is scheduled to be held in California in 2010 (please contact Marianne Stamm of the California Institute for Justice [marianne.stam@doj.ca.gov] for details. The Second Ibero-American course on Forensic Geology may be held in Brazil in 2011.

Further reading suggestions can be found on the online version of this article.



Moonwalk

Ted Nield reports from the Meteoritical Society meeting in Nancy, on the Giant Impact Hypothesis – a theory that seemed to be moving forward, but is now moving backward.

Ever since 1984, the chemical and isotopic similarities (and differences) between the Earth and its satellite all apparently lent broad support to the widely accepted hypothesis that our satellite was created by a giant impact, early in Earth history. However, isotope geochemists have now become so good at their jobs that they are now creating difficulties for theoreticians, Professor Jay Melosh (University of Arizona) told delegates at the Meteoritical Society's 72nd Annual Meeting, Nancy, France.

It used to be all so neat. The Giant Impact Hypothesis explained so much – from the angular momentum of the Earth-Moon system, to the lack of metallic iron in the Moon's makeup. The Moon, it was said, was exactly what you'd get if you took some Earth Mantle, vaporised it and allowed it to condense in the vacuum of space so that the volatiles were lost. The proposed giant impact created a magma disc, of perhaps two lunar masses - and from that the Moon condensed. Computer simulations suggested that 70% of the Moon's mass would have come from the impactor, while only 10% of the Earth's total mass was contributed by the interloper.

And it is from pulling at that last thread of evidence, that the theory has now begun to unravel, says Melosh. In 1984, our knowledge of the oxygen isotope composition of the Moon was such that the obvious similarities to Earth were not an embarrassment. Because if 70% of the moon came from the impactor, one would expect to see some dissimilarities. Oxygen isotope compositions vary widely between different solar system bodies, and it would be extremely unlikely that a wandering impactor would just happen to possess exactly the same oxygen isotope profile as the object it hit.

But then the isotope measurements got more accurate. Now they are accurate to five parts per million, and the similarities have not gone away. If anything, the increase in accuracy has only served to underline the common identity of the Earth and Moon's oxygen isotope profiles. So how can this be?

In 2007 Pahlevan and Stevenson, in an influential paper in *Earth and Planetary Science Letters*, sought to explain how the two bodies could have become isotopically homogeneous. They envisaged a turbulent "atmosphere" of vapour enveloping both proto-Earth and orbiting disc (the proto-Moon). This, they thought, might recycle material from the rapidly spinning Earth, through the vapour phase and into the disc – and back again, thus gradually homogenising the oxygen isotopes between the two. By the time the disc collapsed and the Earth and Moon became finally established, they would have become isotopically identical – while preserving their chemical differences. Hey presto: model saved.

Melosh isn't convinced. He thinks there is a snag with this idea – two snags, in fact, and they're big ones. His calculations suggest that nearly five disc masses of material would need to be exchanged in order to increase the similarity of isotope composition by a miserable one percent. Not only that, but exchange of mass on such a scale is surely impossible without proportional exchange of angular momentum. The Earth-Moon system has far too much angular momentum for this to have happened – unless there exists some presently unknown way of exchanging mass without angular momentum, of course. But that's a big ask.

The mechanisms so far imagined for equilibrating isotope composition seem impossibly ineffective, and may anyway be physically impossible, because of the angular momentum problem. In other words, it appears that the Giant Impact Origin model – once hailed as the answer to one of the oldest conundrums in planetary science, is turning out to be a bit of a *kaputschnik*.

Melosh told the Meteoritical Society that there were several possible ways forward (apart from employing the ostrich method, blithely assuming an isotopically identical impactor). As ever in physics, there is a potential problem with assumptions. The Smoothed Particle Hydrodynamics (SPH) models currently used to model the Grand Impact may not accurately reflect the actual mix of materials achieving orbit. Indeed, this seems more than likely because SPH methods are, says Melosh, notorious for underestimating degrees of mixing. Maybe, too, physicists are underestimating the momentum of a partly molten planet.

However, he concluded: "increasingly precise measurements of the isotopic ratios of element composing the Earth and Moon have brought us to a new crisis in the still unresolved problem of the Moon's origin". Melosh even wondered whether good old George Darwin, son of Charles, and originator of the "Moon spun from the Earth" hypothesis, might be waiting in the wings.

Fissiparturition anyone?

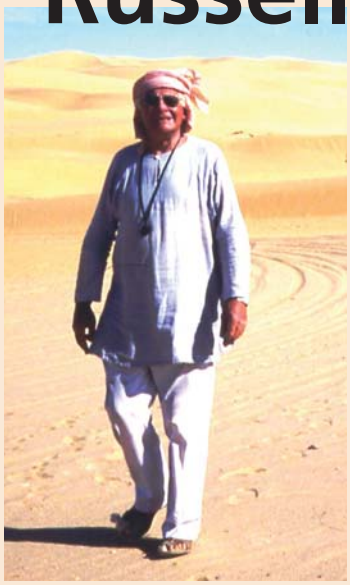
Refs

1. Pahlevan K and Stevenson D J, 2007: EPSL 262: pp438-449

This was one of a number of stories filed by Ted Nield throughout the Meteoritical Society meeting in July. To read more, go to Geonews at www.geolsoc.org.uk/geoscientist.

ONLINE SPECIAL

Russell Black



*African geologist was also a gifted artist, says Peter Bowden**

After obtaining his Scottish Higher Leaving Certificate in 1946, Russell Black (1930-2009) hesitated between going to Art School or University. He went for interview at the University of Aberdeen where he met Head of Geology T C Phemister, who persuaded him that art and geology were intertwined. Russell accepted the challenge, admiring Phemister not only for his Earth science but also for his ability as an excellent painter! Black went on to combine his art and geology throughout his life. Read more, and see examples of his art in the Online magazine – www.geolsoc.org.uk/geoscientist.

Further information: Obituary: http://www.geolsoc.org.uk/gsl/society/history/obituaries/page5811.html

* *Université Jean Monnet, St. Etienne.*

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Marble Bar Chert Member. The bands showing blue are presumably the 'black chert' and the red and white cherts are clearly visible. The outcrop is near vertically disposed. Photo: Joe McCall.

IN *Brief*

Old oxygen

It has long been widely accepted that the Earth's atmosphere and oceans contained little or no oxygen at any time prior to the so called 'great oxygen event' between 2300 and 2200 Ma[1,2]. However, significant levels of free oxygen have recently been recognised in the Neoarchaean, so the question arises: "when did significant levels first appear?"[3]. Oxygen was probably produced by photosynthetic organisms - of which only bacteria were likely to have been extant in the Neoarchaean. The evidence for oxygen comes from organic carbon, microfossils(?) and stromatolites. The suggestion is that such bacteria existed right back to about 3500Ma. Once formed, the oxygen could have been removed by a variety of agencies and reactions, and the level might have fluctuated.

Hoashi *et al* [4] have now reported drilling to >200m depth, beyond the depth of present-day near-surface oxidation, in the Marble Bar Chert member of the Duffer Formation, Pilbara, Western Australia (as part of the Archaean Biosphere Drilling Project (ABDP)). The red beds (picture) in this on-end member contain very fine haematite, taken as evidence of oxygen's being present at the time of deposition in the ocean.

The drilling shows that the haematite does continue below the deepest intersection. The haematite is in the red chert , which is concentrated in the upper part of the member: the black chert forms veins that intrude the white and red chert, but not the overlying Apex basalt, dated at ~3460 Ma. Therefore all three types of chert formed before the basalt eruption at ~3460 Ma, during deposition and diagenesis. The haematite forms very small crystals and neither siderite nor magnetite show evidence of oxidation. Hickman[3], who has had a long career deciphering Pilbara rocks, believes that the depositional environment in the Marble Bar Member changed from anoxic/sideritic, when siderite was deposited, to oxic/haematitic (when haematite and magnetite formed up to 10%), and that the minerals were precipitated close to hyrdothermally active volcanic vents, the basin being successively flooded by water of a different composition. He hypothesises a caldera situation.

This new research seems to have established that the haematite *is* a primary precipitate, not an oxidation product of magnetite or siderite – which means that oxygenated sea-water was then in existence. Whether it established that cyanobacteria were extant seems beside the point: the famous putative cyanobacteria at North Pole in the Pilbara have been questioned[5] and even said to be inorganic; though the presence of stromatolites there and elsewhere of this great age seems to be well established and the Neoarchean in the Pilbara is riddled with them.

Though Professor Malcolm Walter has very reasonable reservations about the Marble Bar evidence (for the existence of cyanobacteria) because these rocks are so ancient and altered[5], this research does seem to establish that there was at least local oxidation of sea water, at least from time to time during the early Archaean. Whether this, even if possibly related to bacteria, was of global significance remains questionable. *JMcC*

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Saw it coming

In October 2008, a small asteroid named 2008TC_3, was discovered by telescope observation[1]. It had a flat reflectance spectrum in the 554-995 mm wavelength. It later hit the Earth, exploding at 37 km altitude. In the absence of a firm link between individual meteorites (falls or finds) and their asteroidal parent bodies, asteroids are characterised and grouped into classes by virtue of their light reflectance. This not very satisfactory, but is the best that can be done. Though the asteroid Vesta has been confidently linked with the HED (Howardite, Eucite, Diogenite) achondrites, there is no certainty that this is correct, and few other reasonably valid linkages have been made. An impact in the Sudan, 20 hours after the asteroid discovery, resulted in a ground search, and 47 meteorite fragments were found, of total weight 3.95 kg, and named Almahata Sitta.

This was a remarkably lucky success for the Spacegurad Survey - asteroids of such size (4m diameter) hit the only Earth once per year[2]. A decade or so this fraction of the sky was covered only on a monthly basis, but is now covered several times per month, and improvements are in the pipeline for such NEA (Near Earth Asteroid) surveys. The prospect of linking asteroid observation and recovery from observed falls are thus very good and improving in the future. The mass was of a rare meteorite class - a polymict ureilite (achondrite), ultra fine-grained, with large carbonaceous grains. The combined asteroid and meteorite reflectance spectra identify the asteroid as of F class, which is now firmly linked to the dark carbon-rich ureilites. Such fine grained and porous ureilite material was not previously represented in museum collections. *JMcC*

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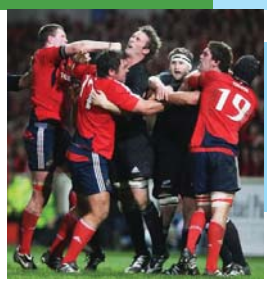
- Go to www.geolsoc.org.uk/geoscientist for more on this by Ted Nield at the Meteoritical Society, Nancy, July 2009.



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Geologic Setting

The Caribbean Plate forms part of Middle America where four marine areas, the Gulf of Mexico, the Yucatán Basin, the Cayman Trough and the Caribbean Sea (Colombian and Venezuelan basins), large continental blocks (Maya and Chortis) and many islands are dispersed between North and South America .

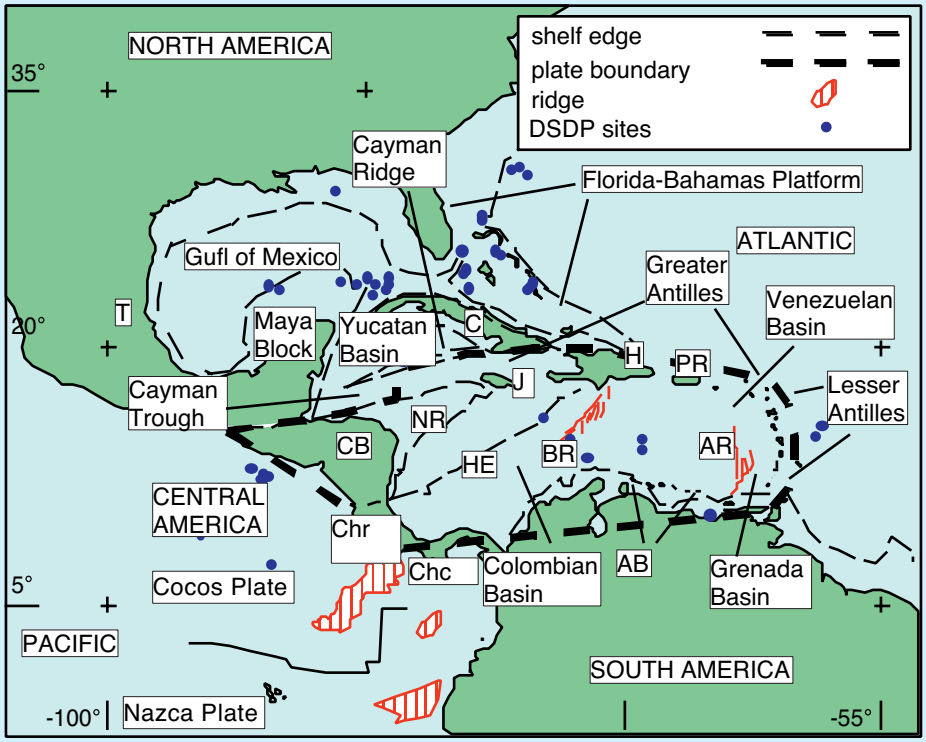

Figure 1: Middle America. The Gulf of Mexico is intracontinental, surrounded by southern North America and the Florida-Bahamas, Tehuantepec (T) and Campeche (Maya) platforms. Cuba (C), with basement and Mesozoic carbonate cover intimately related to Florida – Bahamas, bounds the Yucatán Basin to the north; the Cayman Ridge separates it from the Cayman Trough. The Chortis Block (CB), with its marine extension, the Nicaragua Rise (NR), forms about a third of the Caribbean Plate and is the only place where continental crust is currently recognised. Chorotega and Chocó (Chr, Chc) link Chortis to South America as Central America. The Greater Antillean islands of Jamaica (J), Hispaniola (H), Puerto Rico (PR) and the northern Virgin Islands, large, mostly submerged blocks separated by narrow deeps, lie along the northern Caribbean Plate boundary. The southern plate boundary runs along northern S America. On the plate interior the Beata and Aves Ridges (BR, AR) separate the Colombian Basin - Venezuelan and the Venezuelan - Grenada basins. Sinistral and dextral strike slip on the northern and southern plate boundaries and the Lesser Antilles volcanic arc mark westward movement of North and South America relative to the Caribbean. The Pacific Cocos Plate converges NE with Central America, where volcanism also occurs.

* Institute of Geography and Earth Sciences, University of Wales, Aberystwyth; Professor of Advanced Stratigraphy, Central University of Venezuela, Caracas, resp.

*The Pacific Origin Paradigm (POP) should be questioned for the Caribbean Plate, say Keith James and Maria Antonieta Lorente**

Understanding the Caribbean Plate understanding is hampered by many factors. The relevant geology is spread over many countries; there is a lack of ocean fracture patterns, magnetic anomalies and recognised spreading ridges

POP

(except for the Cayman Trough centre). Lastly it is hampered, we believe, by its presumed origin in the Pacific – the so-called "Pacific paradigm".

Unquestioning acceptance of this paradigm creates two problems. First, many projects are premised (and funded) upon it. Second, all data are interpreted in an oceanic context. As a result, we believe, strong resistance meets any alternative model – even though such alternatives could not only open up important possibilities for exploration, but also allow improved risk management in seismic areas.

Pacific Origin Paradigm

The Caribbean Plate was originally thought to have formed in place; but in 1966, Wilson suggested that the Caribbean and Scotia plates were tongues of lithosphere intruding between North and South America, South America and Antarctica, like interfingering ice sheets[1]. The Pacific origin of the Caribbean Plate has since become the paradigm[2,3].

The POP model holds that the plate formed in the Pacific during the Jurassic, thickened into an oceanic plateau in the Cretaceous above a mantle plume/hotspot (or above a "slab gap" in subducting "proto-Caribbean" crust) and then moved between the Americas. It collided with a west-facing volcanic arc, blocking subduction and reversing polarity. The arc collided with Yucatán and Colombia, subducting to 70 – 80km and inducing high pressure, low temperature (HP/LT) metamorphism.

Volcanic activity ceased during Eocene to Oligocene oblique (and diachronous) arc collision with the Florida-Bahamas platform and northern South America. HP/LT rocks resurfaced in Cuba and along northern Venezuela. Slab roll-back in two different

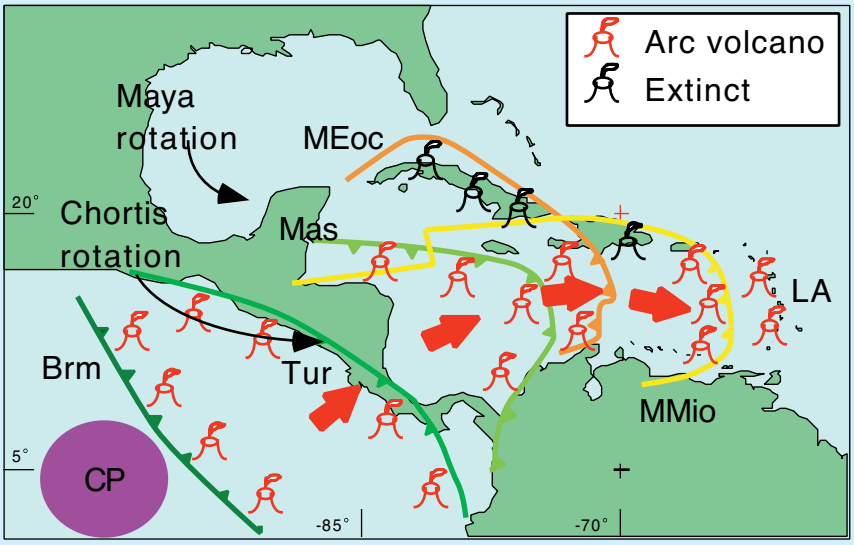

Figure 2: Caribbean Plate (CP) migration from the Pacific (Central America, outlined, not present at that time). Arrows show rotations of Maya, out of the Gulf of Mexico, and Chortis, from SW Mexico, which followed the plate and accreted to its NW corner. Chorotega and Chocó (Fig. 1) are intra-oceanic arc + accreted oceanic rocks on the western tail of the plate. Note impossible bending of a linear arc, which must be rooted in crust, into an extreme curve.

goes the Paradigm?

directions opened the Yucatán Basin to the south of Cuba. These elements joined North America as the plate boundary transferred to the Cayman Trough, where spreading accompanied 1100km of eastward plate movement. Cenozoic Grenada Basin inter- or back-arc spreading separated the Aves Ridge from the Lesser Antilles, the active remains of the arc. Chorotega and Chocó are seen as intra-oceanic volcanic arcs with accreted oceanic rocks on the trailing edge of the Caribbean Plate.

This model regards the Caribbean Plate as comprising mainly oceanic crust surrounded by volcanic arc rocks. It requires the subduction of large areas of the plate below South America and rotation of the large continental blocks of Maya (135° counter clockwise or 100° clockwise) and Chortis (180° counterclockwise or 80° clockwise).

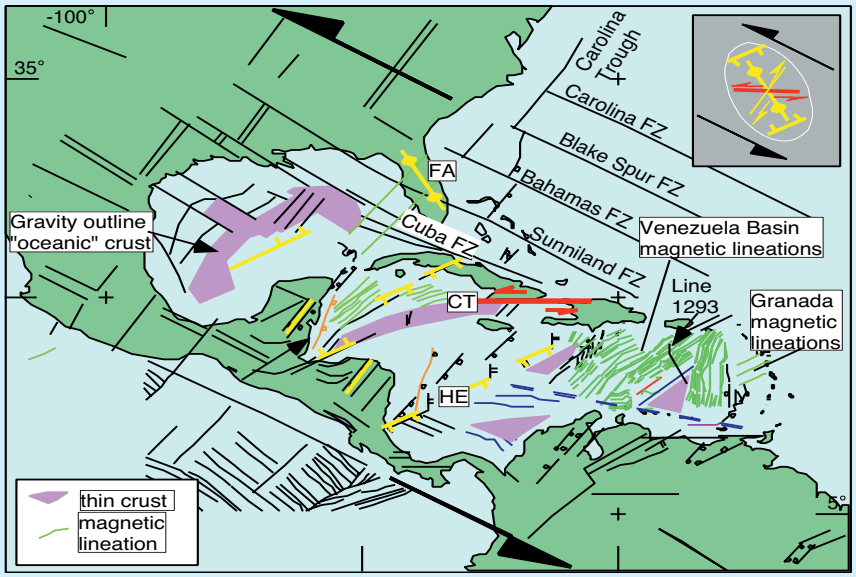

Fig. 3. Tectonic fabric of Middle America. Sinistral offset of North from South America along N60°W fractures/intracontinental faults reactivated N35°E palaeolineaments as dextral faults, generated N60°E normal faults (e.g. Hess Escarpment HE), E-W sinistral slip along the northern plate boundary (early Cayman offset CT) and the Florida Arch (FA).

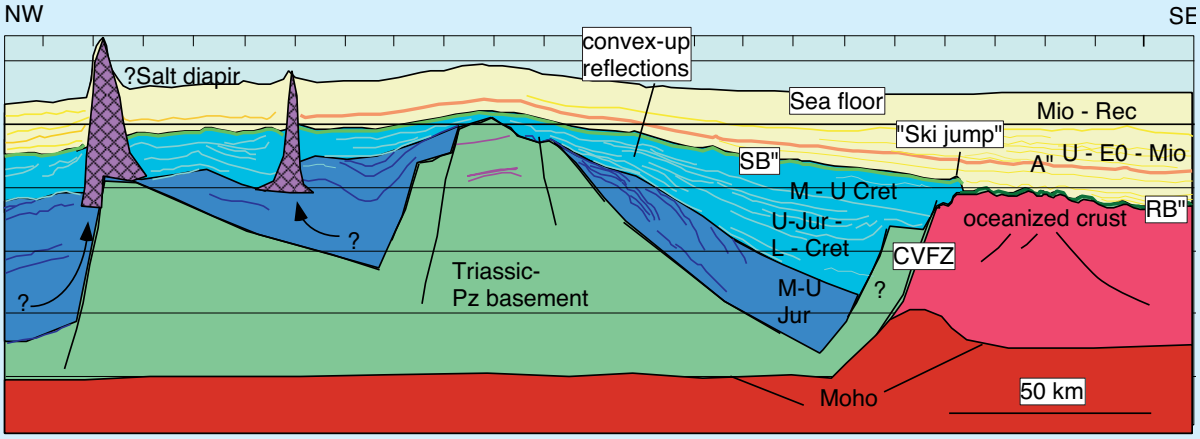

Fig. 4. In-situ interpretation[8] of seismic line 1293 over the Venezuela Basin (line location Fig. 3). Line and original interpretation, showing 40 km wide highs of vertical dykes flanked by volcanic flows, with local seamounts, in Diebold et al. 1999 (Figs. 2, 15)[9].

An *in situ* "antiparadigm"

The in-situ model [4-5] suggests that Caribbean Plate formed in place between the diverging Americas, just as the remarkably similar Scotia Plate is known to have formed by spreading and dispersal of continental fragments between South America and Antarctica[6].

Diverse geological data show that geology between North and South America shows regional harmony and a shared history among its many geographic components. The regional tectonic fabric (Fig. 3) reflects reactivation along ancient lineaments, and shows that no major block rotations occurred. Crustal thicknesses of up to 45km, gravity data and the high silica content of igneous rocks indicate that continental fragments underlie the whole of Central America[7] and the Greater and Lesser Antilles. Seismic data (Fig. 4) suggest that they underpin the thick "plateau" of the Venezuelan Basin[7] and parts of the Colombian, Yucatán and Grenada basins. Salt diapirs are present.

The history of the Caribbean Plate involved Late Triassic formation of the Central Atlantic Magmatic Province, Triassic to Jurassic rifting, Jurassic to early Cenozoic extension, and Oligocene to Recent strike-slip. This continues that seen along the eastern seaboard of North America, but in a more extensional setting that promoted volcanism, foundering, eastward plate growth by back-arc spreading, and distribution of continental fragments on the plate interior and margins.

Subsidence of proximal areas (Bahamas and Yucatán-Campeche platforms, Nicaragua Rise) accommodated kilometres-thick carbonate sections. Horsts of continental crust flanked by wedges of Jurassic-Cretaceous sediments, flows and salt formed in more distal areas along the eastern margin of North America and within Middle America (Yucatán, Colombian and Venezuelan thick crust). The shallow/subaerial flows represented by smooth seismic Horizon B" capped thick crust in the late Cretaceous. Extreme extension serpentinised the upper mantle, forming rough Horizon B".

While the Gulf of Mexico remained largely intra-continental, the Caribbean - west of diverging fractures in the Central Atlantic and a lengthening Mid Atlantic Ridge - suffered greater extension. Middle and Late Cretaceous and Middle Eocene convergence led to a pause in, or cessation of, volcanic activity; uplift to wavebase/subaerial erosion, and development of regional unconformities and shallow marine carbonates. The Mid-Cretaceous change of chemical composition (from primitive to calc-alkaline) records continental input. Restricted marine, organic-rich sediments formed, along with Late Cretaceous subaerial flood basalts.

The Middle Eocene event resulted in emplacement of enormous olistoliths (up to 5km thick and 1000km long) onto plate boundaries and terminated most volcanic activity along the northern and southern Caribbean plate boundaries (coeval, not diachronous). Oligocene to Recent strike-slip followed, corresponding to 300km of central Cayman Trough spreading - the only identified spreading and magnetic anomalies in Middle America. The Caribbean Plate extended eastwards over Atlantic crust. Scotia Plate analogy suggests back-arc spreading along the Aves Ridge.

Indications that continental fragments lie below the Caribbean "Plateau" and the Greater and Lesser Antillean and Central American volcanic arcs suggest caution in assuming purely intra-oceanic origins for oceanic plateaux and volcanic arcs[9]. Accepted discriminatory chemical/isotope data for such areas need to be statistically qualified and examined independently of their presumed origins to see what messages they carry.

Models for the Pacific origin of the Caribbean Plate models are complicated, with many processes difficult to explain or test. The in-situ model incorporates data in a regionally coherent, simple evolution that conforms to the wider geology of eastern North America and the Gulf of Mexico. It can be tested by re-examination of existing samples, seismic data and deep sea drilling.

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Reviews

Books available for review:

- Edmunds, W.M. & Shand, P. (eds) (2008), *Natural Groundwater Quality*, Blackwell.
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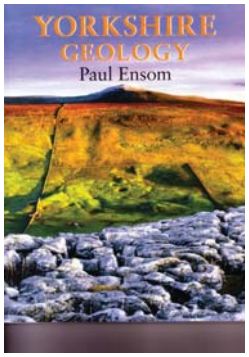


Yorkshire Geology

Paul Ensom
Published by: The Dovecote Press
Publication date: 2009
ISBN: 978-1-904-34964-8
List price: £22.50
192 pp

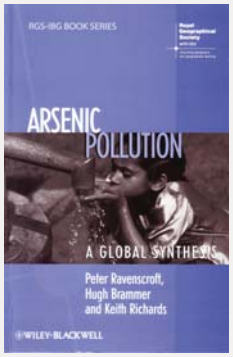
www.dovecotepress.com

Yorkshire is England's largest county and, in its varied and often magnificent scenery, displays a matching range of exposed strata, from early Ordovician to the present. There have been several distinguished and still widely revered and utilised accounts of its geology, dating back to the early 19th Century, but this new offering by Paul Ensom is to my knowledge the first that is directed so unashamedly at the general public and non-practising geologist. A fair indication of the style of writing and the intended audience is given by the racy chapter titles.

The book is attractively produced with generally excellent illustrations, including several global palaeogeographical reconstructions. After some introductory and summary chapters, the rocks are considered from the oldest upwards - with descriptions of their lithology, thickness, facies variation, palaeogeography and main contemporary life forms. There are a few minor factual errors, but in no case would the reader be misled in any significant way. The text is generally well written and easily understood, though I would have welcomed the addition of some cross-sections to better clarify the complex facies and thickness changes in the Upper Palaeozoic and Mesozoic rocks. Another valuable feature of these chapters is the emphasis on the (regrettably, mainly former) commercial value and varied economic uses of the rocks. The final chapters on water and meteorite occurrences, despite their undoubted value and interest, rather have the feel of add-ons, and perhaps room for the information they contain could have been found elsewhere in the book.

There are numerous books available to the general reader on particular aspects or specific areas of Yorkshire geology, but this book is the only one that I have come across that covers the whole county in a comprehensive manner. Unfortunately, at £22.50 is seems rather expensive, compared for example with the £12.50 being asked at Amazon for Tony Waltham's recent book on the Yorkshire Dales. Nevertheless, Paul Ensom and his publishers have generally achieved their aims and the book should be widely welcomed, particularly by the many non-specialist readers interested in the region. It will also be invaluable as a teaching aid in schools. In addition, many professional geologists, whatever their links to the county, will eagerly find a ready space for such an attractive book on their bookshelves.

Doug Holliday



Arsenic Pollution: A global synthesis

P Ravenscroft, H Brammer & K Richards
Published by: Wiley
Publication date: 2009
ISBN: 978-1-4051-8601-8
List price: £34.99
616 pp

www.wiley.com

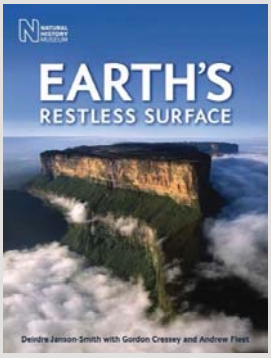
Few elements of the periodic table are as evocative as arsenic, and most people if asked would probably associate it within its historical literary context as a poison. However, the nature and occurrence of arsenic in the environment and the physical evidence for the cumulative health effects to humans subjected to long-term exposure remains a relatively modern discovery; the vast majority of the systematic research having occurred since the 1980s. This book aims to capture this recent scientific expansion and provide an up-to-date interdisciplinary account on the extent of arsenic pollution across the planet.

The book has a number of major strengths, the primary one being that there is a clear definition between the separate parts of the text. The first part of the book is dedicated to providing the reader with all the background information and technical data needed to understand fully the physical and chemical attributes of the behaviour of arsenic in the environment, particularly relating to water supply issues and human health. The second part of the book provides a geographical focus with three comprehensive chapters on the characteristics, impacts and activities relating to arsenic pollution in different areas. In this way, the book achieves its second objective, which is to appeal to as wide a reader audience as possible. The scientific research community, practitioners in the water supply industry, aid and development officials, health workers and the general reader will all find interest in this book.

Each chapter clearly identifies the aims of the text and this consistent approach, together with the use of clear, well-illustrated diagrams and numerous tables of data, allow the reader to understand fully each of the technical sections in turn, as well as the geographical context explored later in the book. The content is accessible, enabling the reader to dip in and out of the text to find reference to a particular issue. It is well indexed throughout and the comprehensive bibliography provides access to further material if required.

This is an excellent book. For those seeking first-time knowledge, as well as those seeking to enhance their existing understanding about arsenic and recent research developments, there is probably no better book currently available - excellent value for money!

Phil Merrin
United Utilities, Warrington



Earth's Restless Surface

Deirdre Janson-Smith, Gordon Cressey, Andrew Fleet
Published by: The Natural History Museum, London
Publication date: 2008
ISBN: 13 978 0 565 09236 8
List price: £9.99
111 pp

This is a well-written book illustrated with large, attractive, relevant photographs and clear explanatory diagrams - good value at £9.99. It is suitable for someone starting a study of geology or physical geography, such as an A/AS level student, first-year undergraduate or just anyone who is interested in how the world works.

The book begins with a general discussion of geology including uniformitarianism, the history of geology, plate tectonics, timescales and change. It goes on to discuss climate, the atmosphere, the biosphere, the hydrosphere including ocean currents, and the solid crust, including landslides, volcanoes and earthquakes, concepts of time and scale vs. change. It compares forces (such as ice) that act slowly and continuously, with forces such as landslides, hurricanes and tsunamis which can act rather more quickly.

The authors also consider the processes that give rise to sediments - weathering, erosion and deposition - and go on to consider the landscapes formed from these and other rocks. A desert landscape, a coastal landscape, an ice-formed landscape and a living landscape (coral reef) are given as examples. A brief history of plate tectonic movements covering the last 500 million years is provided, as are brief explanations of some famous geological localities in the UK.

As in many geology books at the moment there is a discussion of climate change but decides that as many factors are involved it is difficult to draw many firm conclusions about the future development of the climate. The book describes the value of computer models in predicting future atmospheric changes being brought about by burning fossil fuels. The authors conclude that at the beginning of the 21st Century the link between carbon dioxide (and other greenhouse gases) and global warming lies beyond reasonable doubt. How the pace of that change can be slowed will partly depend on technological advances, but above all else will be a matter of individual and political will.

Steve Rowlatt, Bishop's Stortford

Harappan collapse

The fall of the Harappan Civilization has been associated with rapid weakening of summer monsoon rains. New work now shows that changing river patterns may also have played an important part in their demise. Peter Clift reports.*

Sunset over the Indus River at Sukkar, northern Sindh Province

Photos: Peter Clift

Throughout history human societies have prospered or failed, not only because of their relationships to other cultures, but also because of environmental conditions affecting a range of key issues, including agriculture and drinking water supply. Periods of rapid climate change are particularly dangerous, as existing communities struggle to adjust to new conditions. Studying cultural decline in periods of climate change past, should help us plan for our own uncertain future.

No period is better for illustrating the interrelationship of environment and culture than the Late Neolithic, when the Indus, Akkadian, and Longshan civilisations all appear to have experienced a major shift in the way they lived. The Indus Valley, or "Harappan" civilisation (see Box) was one of the earliest advanced urban cultures known to archaeology - and appears to have collapsed around 2000 BCE.

Indus Valley Civilisations

The Indus Valley Civilisation (mature period 2600–1900 BCE) flourished around the Indus River basin and encompassed most of what is now Pakistan (mainly the provinces of Sindh, Punjab and Balochistan), as well as Indian states Gujarat, Haryana, Punjab and Rajasthan. IVC remains have been found in Afghanistan, Turkmenistan and Iran. The mature phase of this civilisation is technically known as the Harappan Civilisation, after the first of its cities to be unearthed - Harappa in Pakistan.

The civilisation is sometimes referred to as the Indus Ghaggur-Hakra civilisation or the Indus-Sarasvati civilisation. The appellation Indus-Sarasvati is based on the possible identification of the Ghaggur-Hakra River with the Sarasvati River mentioned in the Rig Veda, but this usage is disputed on linguistic and geographical grounds.

Earlier palaeoclimate work has suggested a link between the end of settlement in major urban centres and a rapid weakening of summer monsoon rains. However, life may prosper in arid environments as long as it can be sustained by large river systems. The Leverhulme Trust has therefore funded a new study involving a diverse international group of scientists to explore the role that drainage reorganisation in the Indus Valley may have had on societal change at that time.

Our campaign of trenching and drilling across the flood plain of the Indus River system in western India and Pakistan is beginning to quantify, for the first time, how the Indus River and its major tributaries have changed over the last 8000 years - a period when summer monsoon rains were stronger than they are today. Although sedimentation continues to be active in the lower reaches of the river system, the new data show a cessation in sediment deposition in the north as the monsoon weakened and the supply of sediment from the Himalaya reduced.

Provisional age data now show that between 2000 and 3000 BCE, flow along a presently dried-up course known as the Ghaggur-Hakkra River ceased, probably driven by the weakening monsoon and possibly also because of headwater capture into the adjacent Yamuna and Sutlej Rivers.

The possible impact of drainage reorganisation on early cultures in South Asia has long been a matter of debate, but has been consistently hampered by a lack of hard data. Major river reorganisation causes many problems for civilisations - as can be recognised in the repeated

changes in course of the Yellow River in China over the past 1000 years, and the subsequent displacement of populations. More recently, the Kosi River floods of Nepal and India in summer 2008, caused massive disruption.

Abandoned former courses of the River Indus have also long been recognised, in the form of dried-up river channels along the edge of the Thar Desert. These were observed as long ago as the 1920s and 30s, in the work of Sir Marc Aurel Stein. More recently, they have been mapped in great detail using aerial and satellite images, and it has been possible to delineate the course of a now defunct "Ghaggur-Hakkra" River, which once ran from the Himalayas, between the Sutlej and the Yamuna Rivers. This palaeo-river was well positioned to have sustained the Harappan civilisation; though the age of water flow, and the patterns of interconnection between channels (and to the Indus itself) have remained speculative.

Drilling

Following drilling in the Indus Delta by myself, Liviu Giosan (Woods Hole Oceanographic Institution) and Ali Tabrez (Pakistani National Institute of Oceanography) it has become clear that since the Last Glacial Maximum (around 20,000 years ago) the Indus experienced great changes in the composition and volume of sediment flowing through its channels. These changes appear to be linked to the changing strength of the summer monsoon rains.

Building on this earlier study, Clift and Giosan, together with Mark Macklin (Abersytwyth University) have initiated a new project to constrain how the river has evolved since the middle Holocene, ~5000 BCE. In 2008 Anwar Alizai and Sam VanLaningham (University of Aberdeen) undertook the first field excavations on the floodplain in the Pakistani state of Punjab, where the supposed Ghaggur-Hakkra River used to flow.

Using mechanical diggers (and local workmen where these were not available) they dug trenches into the deposits of the Holocene outwash plain. Targeting the channels themselves was hard, even with the aid of high-resolution satellite images. But in the end they were able to sample the flood plains of the palaeo-rivers, which allowed the team to start narrowing down when the river was flowing, and where its sediments were coming from.

Dates of sedimentation were obtained by radiocarbon dating freshwater gastropod shells and woody material recovered from the pits. Together, these showed that active river-flow along the Ghaggur-Hakkra had finished before 2000 BCE, at least in that region. New optically stimulated luminescence (OSL) ages, which measure the time since sediment was last exposed to

Sir Marc Aurel Stein at his tent in 1929 in central Asia during his many expeditions concerning the archaeological history around the periphery of British India.

Liviu Giosan and Ali Tabrez sample sediments from a pit dug by excavator in the flood plain.

Map showing the features covered in this study

sunlight (produced by Geoff Duller, Helen Roberts and Julie Durcan at Aberystwyth) support this general scenario.

Today, the Ghaggur in India is a very small river, within a modest mountain catchment. How could it once have been a much larger stream? We believe it is possible that the river was once swelled by other headwater catchments that are now diverted into other directions. The neighbouring Yamuna and Sutlej Rivers are the most likely candidates for this, and could well have been captured from the Ghaggur during the Holocene. If either or both of these streams formerly flowed into the Ghaggur channel then the river could have been very much larger than it appears today.

It is clear that the Indus has experienced major changes since the mid Holocene, when the whole system appears to have been in active deposition. However, since that time the northern reaches of the Indus and its various major tributaries have incised river valleys 20–30 m deep. What caused this change in behaviour? A number of possibilities are presently in contention.

While delta drilling proved that the early Holocene (11,000 – 8000ka) was a time of very rapid sediment flux, probably driven by fast erosion under the influence of a strong summer monsoon, the period since 8000 years ago has been one of weakening rains and reduced sediment flux, as established from lake sediment records in India and in cave records from Oman. In this case, the river may be "cannibalising" itself in its upper reaches, reworking the older floodplain sediments over which it is now flowing.

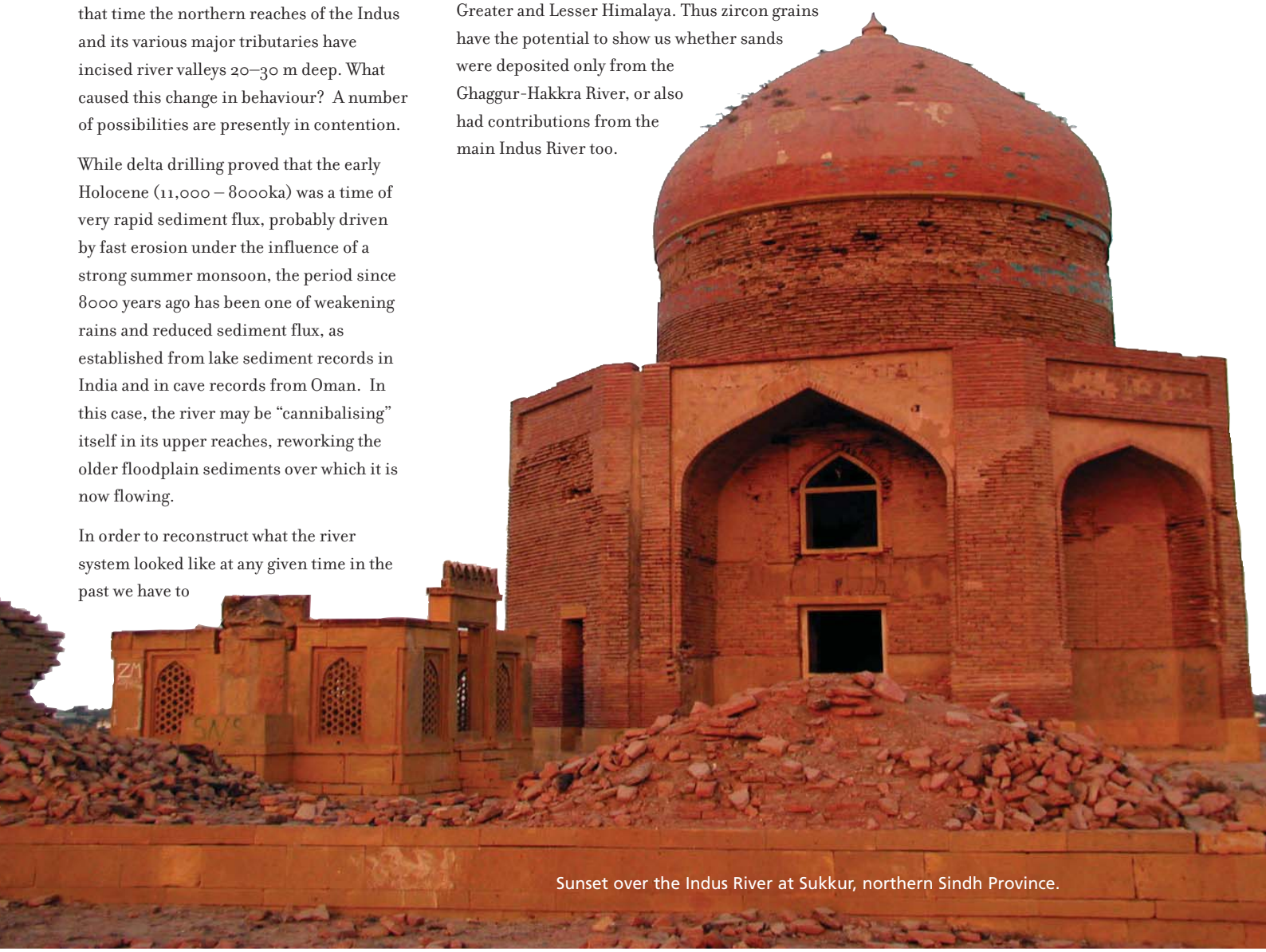
In order to reconstruct what the river system looked like at any given time in the past we have to know the provenance of the sediments in its overbank deposits. This can tell us how each tributary was connected to its neighbours and indeed to the trunk stream itself. In this respect the Indus is a great system for geologists because it receives sediment from several sources, with each characterised by quite different geochemical characteristics and ages.

Zircon to the rescue

The western Himalaya are especially heterogeneous with respect to the U-Pb age of zircon grains. Grains from the Lesser and Greater Himalayan Range display old zircon ages of around 400 Ma, 1000 Ma and 1800 Ma and older, whereas the Karakoram and Kohistan typically display ages younger than 250Ma - representing Andean-style magmatism along the southern edge of Asia, prior to its collision with India. This makes changes in large-scale drainage or erosion patterns easy to spot.

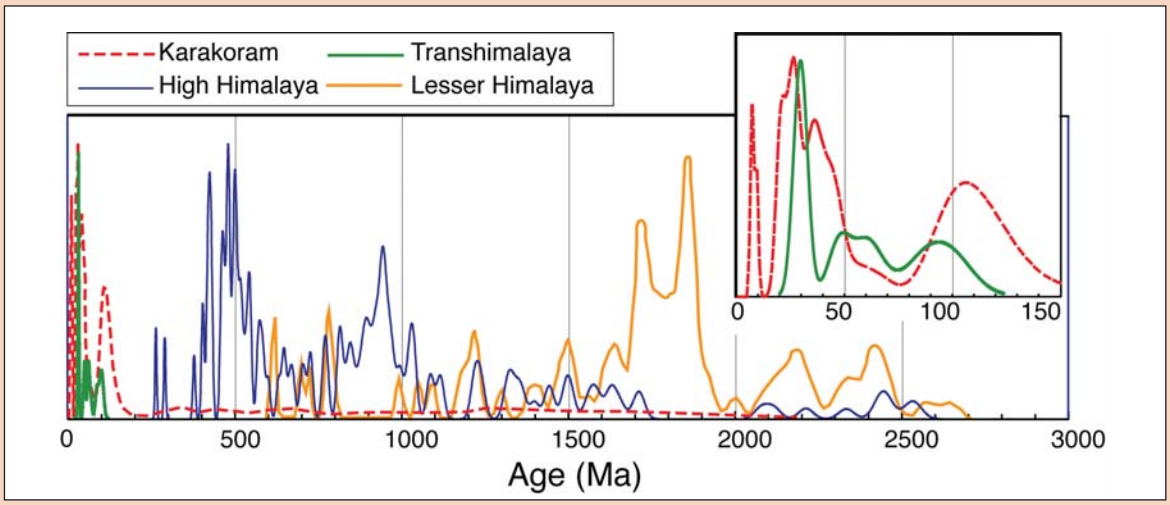
New technology (see Box opposite) now allows large numbers of single grains to be analysed quite rapidly. U-Pb dating of zircon grains tells us when each grain cooled below 750˚C (i.e. the age of its crystallisation from its source magma). The Laser Ablation Inductively Coupled Plasma Mass Spectrometer (LA-ICP-MS) at University College, London, now allows around 100 such grains to be dated every day. Such large numbers are needed for each sample in order to generate statistically reliable data sets.

Andrew Carter who runs this operation has shown that grains younger than ~250 Ma are unique to the main Indus River, whereas the major tributaries of the Indus that join from the east are dominated by much older grains sourced from the Greater and Lesser Himalaya. Thus zircon grains have the potential to show us whether sands were deposited only from the Ghaggur-Hakkra River, or also had contributions from the main Indus River too.



Sunset over the Indus River at Sukkur, northern Sindh Province.

Single Grain Provenance



This probability density plot shows the most likely ages for zircon ages in four of the biggest source terrains in the western Himalaya. Young grains are unique to the Karakoram and Transhimalaya, while even here differences do occur. Grains younger than 10Ma or older than 110Ma (insert) are only found in the Karakoram. Although the Lesser and Greater Himalaya have significant overlap, there are nevertheless ages that are typical of each range and allow a first-order sediment budget to be made.

Improved microanalytical methods in recent years have greatly increased the ease of single grain provenance analysis and our ability to reconstruct ancient patterns of erosion.

Although analysis of entire sediment samples for chemical composition and isotopic character are still widely used determining the relative influence of a number of different sources is impossible in complex river system systems without single grain methods. The best method for a given river is not always the same, but will vary depending on how diverse the source regions are, and what the local history of deformation and magmatism has been.

Lower temperature thermochronometers, such as fission track dating apatite or zircon, can be used to determine when crystals cooled below 110°C and 200°C respectively. Unfortunately, these methods alone are usually insufficient to resolve all sources in the Himalaya. Previously, ion probe methods were used to date the crystallisation of zircon grains, or to determine the Pb isotope character of potassium feldspar sand grains, both of which are heterogeneous across the western Himalaya and Karakoram. Now zircon grains can be dated at lower resolution but at much higher speed and lower cost using a LA-ICP-MS. This is important because statistical analysis demands that more than 100 grains need to be dated for a robust result.

Whereas this used to be prohibitive in cost and machine time, it is now practical - and allows at least one sediment sample to be processed each day. Although the crystallisation dates are not as precise as those obtained with ion probe, the huge differences in crystallisation ages that are known from across the Himalaya allow good constraints to be placed on the grain's origin from even an approximate age.

Drilling rig operated by the Geological Survey of Pakistan drills the flood plain of the Indus at Thatta, close to the modern river mouth.

Initial analyses of the sands sampled in pits on the course of the Ghaggur-Hakkra River at Fort Abbas have shown a significant number of grains with young U-Pb age signatures. At first sight this would seem to require a huge swing in the Indus River, since they were deposited more than 5000 years ago. Although it is possible that the Indus flowed this far east (c. 200km further east than its present course) it seems more likely that the sands found have been reworked from the sand dunes of the Thar Desert, which directly abut the river valley.

Nonetheless, this observation is important. If the Ghaggur-Hakkra River did flow through this channel and connected with the Indus 5000 years ago, then it appears that the river must have ceased to flow before the analysed sands were blown by wind into its channel. What might have caused this cessation in river flow? Although the headwaters of the ancient river may have been lost by capture it is also possible that the river simply died out because its supply of rainwater fell. Other radiocarbon ages from farther south (around the enigmatic Nara River valley) suggest that the sand dunes of the Thar Desert expanded in that region at 5000–6000 years ago. Not only is that conclusion consistent, it is also corroborated by other climate indicators, suggesting a steady decrease in summer monsoon rains.

It now seems that the river system in this region was indeed responding to climate change taking place during the mid to late Holocene. At present, our age control is insufficient to allow conclusive links to be made with the evolution of human societies. Early signs are encouraging, however, that we shall be able to build intriguing bridges between climate and cultural development in SW Asia in the not too distant future.

This is of more than academic interest at a time of accelerating climate change. A more detailed understanding of how the Indus valley river system has responded to climate change during the Holocene will allow for better planning for anticipated changes driven by global warming.

Prof. Peter Clift, University of Aberdeen, is the leader of the Harappan investigation.

A local contractor digs a pit for our study east of Hyderabad on the flood plain in southern Sindh. Such pits are a practical and easy way to study the top 4–5 m without expensive drilling.

Ali Tabrez assists Anwar Alizai in collecting sand samples for OSL dating from a bed underlying modern active dunes in Punjab.

Dark brown muds and sand deposited by river flow are overlain by windblown dune sands in eastern Pakistani Punjab near Bahawalpur.

Society Business

Names for Election to Fellowship

The following names are put forward for election to fellowship at the OGM on 23 September 2009.

ABSOLON, Lyndon Terence; ALLEN, Joseph; ALLEN, Robert; ALLWOOD, Charles William; ANANABA,Martina Onyeche; ATKINSON, Stephen William; BARRETT, Paul Anthony; BELAN, Anna; BENNING, Margaret Carolyn; BIRD, Christian Lloyd; BOBMANUEL, Austin Soberekon; BOURGUIGNON, Laure Felicity; BOYD, Keith Matthew; BOYLAN, Noel; BOYLE, John Andrew; BROCK –HOLLINGSHEAD, Adrian Francis; BROWN, Peter James; BROWN, Christine; BULLEY, Christopher David; BURGESS, Catherine Elizabeth; BUTLER, Adrian Paul; CAMPBELL, Nicola Sarah; CANTRELL, Dave Lee; CAROLAN, Philip Gerard; CARTER, Paul Kissane; CARTER, Gareth Daniel Oliver; CASIOTTI, Paolo; CHAN Yu Jim Caroline; CHAPMAN, Nicholas Timothy; CHENG, Hung Wai; CHURCH, Elspeth Lydia; CLIFTON, Abigail Joy; CORRIGAN, Susan Helen; CORY, Theresa Yin Ying; CZARNECKI, Adam; DIXON, Simon David; ELEGBEDE, Taiwo Michaelo; EVERS, Sarah; EWING, Gillian Mary; EYRE, Amanda Ann; FALCON-LANG, Howard; FLETCHER, David John; FULTON, Kirsty Anne; GALIPP, Karsten E Erich; GARNETT, Annalise; GAUFFRE, Jonathan; GEOGHEGAN, Noel Richard; GERNON, Thomas Michael; GODDEN, Mark; GRAHAM, Jennifer Joan; GRIFFIN, Mark Andrew; HAMPTON, Matthew John; HARVEY, Trevor Dennis; HETHERINGTON, Anna Brid; HEWITT, Kian; HISKIUS, Edward; HO, Sze Yin; HOFFMAN, Paul; HOGG, Iain; HOLLENDER, James; HOLMES, Thomas David; HUGHES, Leanne; JEFFERIES, Daniel; JENKINS, Gareth; JENSEN, Sven Monrad; JOHNSTONE, Warren Peter; JOKANOLA, Olufemi Akande; JONES, Melvyn Travers; JORDAN, Anthony Matthew; KEMP, David Bryan; KEYS, James Andrew; KHALIFA, Fadi Khuder; KOHLSTEDT, David; KUTNER, Anna; LAST, Catherine Claire; LAWRENCE, Claire Jayne; LEE, Lawrence Lok-Yee; LONERGAN John Richard; LUCAS, Dominic George; MACKINTOSH, Shona; MACLENNAN, John Campbell; MACLEOD, Fiona; MARSH, Daniel; MARTIN, Christopher John; MOORE, Fiona Louise; MOORE, Charles; MORGAN, Daniel Ashley; MURPHY, Samuel William; MYERS, Keith Stuart; O'CONNER, Lewis Paul; ODEDRA; Snita; O'DRISCOLL, Brian; O'LOUGHLIN, Benjamin; PATON, Garry Benjamin; PATERSON, Shaun Paul; PAYTON, Charlie Robert; PEEL, David Jeffrey; PENDER, Laura Rachel; PHILLIPS, Stephen James McGregor; PHILLIPS, Oliver William; PICKERING, David Charles; PICKERING, Mark Christopher; PITCHER, James; PITMAN, Stephen Thomas; PITTS, Jonathan; PRICE, Arthur Jonathan; QUINN, Martyn Frank; RAHIMAN, Tariq Iqba Hamid; RENFORTH, Phil; RICHARDSON, David John; RITCHIE, Craig Grant; ROBERTS, William Thomas; ROBINSON, William Anthony; RODEN, Ebony Faith; RUSSELL, Michael; SAWYER, Felicity Sarah Anne; SCAIFE, Gary Nicholas; SCOTT, Jennifer Rebecca; SELBY, David; SHANN, Mark Vincent; SHAW, Mark Harold; SMEETH, Maximilian P E; SMITH, Alexander Jeremy; SOLANA, Maria del Carmen; SPENDLOVE, Samantha Jane; STALKER, Thomas Watters; STATON, Alexander; STEEL, Ian Thomas; STEWART, Michael David; STRAUGHTON, Garry; STUART, Jennifer; SYMMS, Anna Elizabeth; TAMNTA, Nforba Melvin; TAQUET, Philippe; TARVER, James Eric; TASIOPOULOS, Stavros; TAYLOR, Claire; TURNEY, Christian; TWEEDIE, Michael; TYSON, Lloyd William; VALENTINE, Christian Owen; VANE, Christopher Howard; VOADEN, Nigel John; WHITTAKER, Alexander; WHITTINGHAM, Martin Brian Ellis; WILKINSON, Christiaan; WILLIAMS, Adam; WILLOUGHBY, Michelle Fiona; WILSON, Michaela Mary; WILSON, Jordan Neal; WONG, Wing Kin; WOODHOUSE, Brett Russell; WORKMAN, Naomi Leigh; YATES, James Michael

The following Candidate Fellows who graduate this year must upgrade to Fellowship within 12 months following graduation should they wish to continue with membership. Those who complete the application process before the OGM on 23 September will be elected at that meeting. The remainder will be put forward for election at future OGMs and the AGM, as and when they submit their application

Abbott James **Alizadeh** Gharib Hossein **Allott** Joseph Arthur Stewart **Amobi** Nnenna Natalie **Bartlett** Ryan **Bateman** Keith **Beckwith** Stephen **Bhanot** Krishan Kumar **Binks** Matthew Robert **Biswell** Mark Lawrence **Boyce** Julie Ann **Broughton** Christopher Philip **Brown** Thomas Roger Edward **Buck** Darrell James **Burns** Michael **Chadenga** Nicola **Chima** Uzodimma Uczochukwu **Clifton** Sally Elizabeth **Cobbold** Madeleine Fay **Cook** Robert Alexander **Cooper** George Frederick **Cross** Joanna Kate **Crow** Alexander Thomas **Davey** Joanna Rebecca **Deacon** James **Dearn** Geoffrey Stuart **Docherty** Kevin John **Duncan** Colin **Dyson** Andrew **Ellis** Jack Alexander **Escaudo-Ciudard** Carlo **Evans** Ashley **Filmore** Terry Michael **Fordyce** Stuart **Gaffey** Gillian Barbara **Gamboa** Davide **Goff** Matthew James **Hall** George Christopher **Hannah** Steven Alan **Harris** Christopher Michael **Hartley** Ian Mark **Hinder** Alec **Hodgson** Margaret Grace **Hopkins** Louise Anne **Horsburgh** Nicola Jane **Irwin** Gareth **Kalisperi** Despina **Lawley** Francesca Jade **Liakhau** Andrei Alexander **Lord** William **Ludgate** Natalie Frances **Maloni** Elana Dawn Jessica **Marshall** Carly Louise **Matthews** Benjamin Jacques **Matthews** Alison Jill **Mirza** Umar **Molcan** Matey **Morris** Katherine Anne **Mortley** Henry James **Moxon** Frank Hoyt **Mullins** Guy **Nowecki** James Philip **Parker** Emilie **Pepper** Kirsty Ann **Pierce** Colm Stephen **Roberts** Alison Debra **Roberts** Richard Philip **Roper** Kathryn **Sargent** Paul **Schlesinger** Edward Richard Peter **Scott** David Magnus **Sghibartz** Cristina Amanda **Shah** Neil Shaw Robyn Alexis **Shaw** Eleanor Margaret **Simister** Rebecca Esther Carmel **Slatter** Sarah Frances **Smith** Gemma **Spry** Terence John **Steaggles** Hannah **Stockwell** Paul James **Sykes** Martin Alan **Teale** Charles Alexander **Thiakalingham** Surenthar **Towfigh** Sasha **Turnbull** Stephanie Jayne **Walker** Alexander **Weatherley** Samuel Mark **Weilding** Kenneth Geoffrey **West** Geoffrey Peter George **Wilkinson** Luke Philip **Williams** Daniel Blair **Williams** Stephen Mark **Woodhouse** Nicola Suzanne **York** Sarah

Society Awards - deadline

The deadline for nominations for Society Awards 2009 is October 23. To find out how to nominate please visit the website, and click on the hotlink under "The Society" to take you to the "Society Awards and Research Funds" section. There you can download a nomination form. These are now in "rtf" format to enable you to fill them out and submit online.

Changes to terms and conditions

As those who attended the AGM on 3 June this year will know, Council has decided to freeze Fellowship fees for most categories in 2010, to assist Fellows as much as possible during the current economic downturn.

At the same time, Council also approved a move to make the standard Fellowship subscription cover online access to journals only, and to introduce a £10 supplement for all those wishing to continue receiving a printed version. The proposal to introduce the supplementary charge for hard copy was raised at the AGM and met with no dissent.

The impact of these difficult economic times is being felt by the Society as it is by many Fellows. The concern for 2010 is to tighten control of costs while at the same time offering an affordable Fellowship fee. The print and postal distribution of journals to Fellows constitutes a considerable expense and is an obvious area for cost-saving, particularly as many Fellows have made it clear over the years that they find the compulsory delivery of a paper journal oppressive. Council has taken the view that now is the right time to adopt a more environmentally sensitive approach to journal circulation.

Most publishers agree and are now moving towards the adoption of online as standard, and Council believes that the majority of Fellows will be happy to receive online-only access. Council also believes it is only fair that the anticipated minority still wishing to receive a print copy should contribute to the cost of doing so. *Ted Nield*

Online renewals

Edmund Nickless writes: In October we are hoping to be able to offer all Fellows the option to renew their Fellowship online via the Society's website. This online renewal process will be easy to use and will involve a few simple steps. After logging in, Fellows will have access to Fellowship renewals where they will be able to review their membership details, make changes to their journal subscriptions, then pay by direct debit (including instalment plans) or by credit/debit card.

If you would like to take up the option to renew your Fellowship online and not receive a hard copy invoice please could you confirm by September 7 to online-renewals@geolsoc.org.uk. We will ensure that you are included in the list of Fellows to be sent an electronic renewal call only.

Accreditation news

Accreditation Officer Bill Gaskarth, on being an external in Saudi Arabia

Following the Accreditation, in 2008, of the six degree programmes offered by the Faculty of Earth Sciences, King Abdulaziz University, Jeddah, Saudi Arabia, the GSL accrediting panel of John Powell, Bill Gaskarth and Peter Styles were invited to be the first External Examiners for these degrees. They visited the University from June 27 to July 6, looked at the students' work and continued discussions with Earth Sciences Faculty on curriculum development, teaching and examining. There is no doubt that the University supports the Faculty, which is itself responding well to the changes required by Accreditation.

The highlight of the trip was a visit to the KAU Field camp at Ablah in the SW of the Kingdom above the Red Sea Escarpment (pictures). Around 100 students stay there for about four weeks, living in tents and undergoing field training. The facilities and organisation are very impressive and we were able to get an impression of the training and the opportunities for project work here. The geology of the Neoproterozoic Arabo-Nubian Shield is spectacular and excellent for teaching purposes.

An application from King Fahd University in Dharhan is presently with the Accreditation Panel, and it is likely that an accrediting party will visit there in the near future to look at their Geology and Geophysics degrees.

Applications for Accreditation of MSc degrees in the UK are also being looked at and the two MSc degrees in Environmental Biogeochemistry (with consultancy skills) at Newcastle were accredited at the last Accreditation Panel meeting on July 22.

Shell London Lecture Series

Perturbing plankton in the sea: past and future

Wednesday 7 October 2009

Speaker: Rosalind Rickaby (University of Oxford)
Matinée: Tea and coffee 14.30; Lecture 15.00 – 16.00
Evening: Tea and coffee 17.30; Lecture 18.00 – 19.00

This talk will look at the response of the "marine forests", vast blooms of phytoplankton, to future high levels of atmospheric CO_2. Understanding this is crucial to knowing whether the marine biological pump will amplify or hinder future global warming. Recent evidence from rapidly accumulating sediments implies that some coccolithophores, which build exquisite limestone shells, are increasing their calcification in response to anthropogenic change.

Rosalind Rickaby is a young researcher at the University of Oxford, with a fellowship at Wolfson College. Her academic background also includes a PhD from the University of Cambridge and a postdoctoral fellowship at Harvard University in the United States. Recently, Ros was recognised by the EGU as an "Outstanding Young Scientist", won the Philip Leverhulme Prize in 2008 and has just been awarded the 2009 Rosenstiel Medal. Seeking innovative alternative approaches to constraining past climates has increasingly directed her research towards understanding the physiological response of phytoplankton to the changing carbon cycle.

For further information on the Shell London Lecture series and programme for 2009 please visit our website www.geolsoc.org.uk/shelllondonlectures09 . Films of all past lectures can be watched here also.

Sponsored by Shell

Tickets: Entry to each lecture is by ticket only. To obtain a (free) ticket please contact Alys Hilbourne. Please note that due to the popularity of this lecture series, tickets are allocated on a monthly ballot basis and we cannot guarantee that you will get tickets when they are requested.

planetearth® Earth Sciences for Society

Say Yes to YES!

Next month, from October 24-28, the Young Earth-Scientists for Society (YES) network (an association of Earth scientists under the age of 35 years representing geological societies from around the world, in collaboration with the International Year of Planet Earth (IYPE)) is holding its world congress at the China University of Geosciences of Beijing.

The conference will focus on global climate, environmental and geological challenges facing society, and aims to establish an interdisciplinary global network of individuals committed to solving these challenges. Young representatives from the main geological associations and employers, young leaders in politics and those from administrative bodies, are invited to attend and help to build an interdisciplinary global network that will include the world leaders of the future.

To register, visit http://www.yescongress2009.org/.

The Geological Society Club

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

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

2009: 23 September; 21 October; 12 November (Founders' dinner – organised by the Society – please apply to alys.hilbourne@geolsoc.org.uk for tickets, not to the Club. Price £65.)

2010: 13 January; 17 February (Venue tba); 17 March; 21 April (Burlington House) 19 May (Venue tba)

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

Consultations

The Society has received the following consultation documents. Those to which the External Relations Committee has decided to try to co-ordinate a response are marked with an asterisk (*). All Society responses are put on the website as soon as permission is granted by the agency to which the advice is submitted.

Responses are coordinated by Sarah Day (Earth Science Communicator – sarah.day@geolsoc.org.uk) on behalf of the External Relations Committee (Chair - Prof. Edward Derbyshire). Responses are based upon consultation within the Society and approved for release in accordance with the Society policy on public statements (*Geoscientist* v.8, No 2, pp 12-13 – or online at http://www.geolsoc.org.uk/gsl/views).

*** Curious fruits**

The Royal Society has issued a call for evidence for its current inquiry, '*The Fruits of Curiosity: science, innovation and future sources of wealth*'. Details can be found here: http://royalsociety.org/page.asp?tip=1&id=8680

- Deadline for responses: 11 September.
- Deadline for comments to Sarah Day for Society response: **1 September**

If you are interested in contributing your views to any Society response, please check first that the Departmental deadline has not already passed by the time you read this (owing to the brevity of many consultation periods, deadlines may have passed, but details are given for the information of Fellows). Please obtain your own copy of the document and submit your views (email only, in less than 1000 words) to Sarah Day **at least one week before the specified deadline**. Please confine your views to matters that fall within the remit of the Society.

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

From the Library

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

Three more e-journals now available offsite

Offsite access to *Central European Geology, Earth Sciences History*, and *Israel Journal of Earth Sciences* is now available. Visit the Virtual Library (www.geolsoc.org.uk/library) to read more about online access to these journals and the other 58 e-journals already available.

Inter Library Loans

The British Library increased some of their charges from 1 August 2009 by a small amount. The charge for material requested from the BL via the Geological Society Library will be: Electronic copy £8.75 or Photocopy £9.75 + copyright fee (if applicable) + VAT. Book Loans from BL: £13.50.

Sponsor-a-Book Update

The Library would like to thank Mr Anthony Brook, Mr Phil Clarke, Mr Warren Jones and Dr Richard Symonds for very generous donations which allowed us to restore George Cuvier's *'Recherches sur les ossemens fossils de quadrupèdes...'* (1812). The five-volume title, which was in urgent need of conservation, was returned to the Library in June, fully restored to its former glory by Aquarius Book Restorers.

The Library is appealing for donations to help preserve one of the Society's most important archive manuscript books. A prized treasure from the archive, this manuscript book includes numerous letters, tracts and memoirs from eminent early thinkers in geology, including:

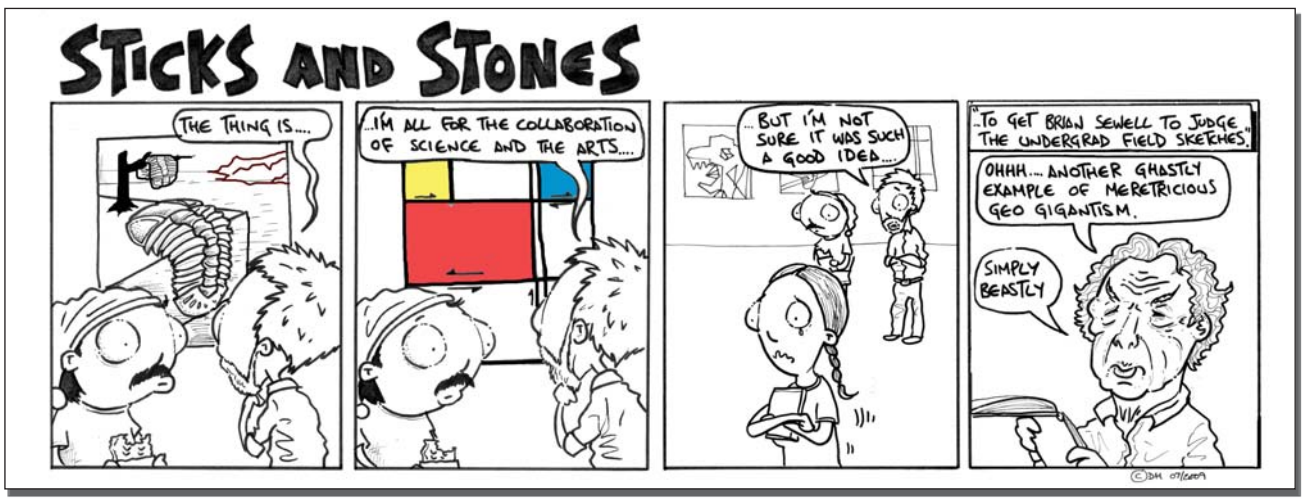
- James Sowerby's '*On Kimmeridge and other coals'* [Carbonaceous sediments of Dorset], a letter to the Secretary for the nomenclature enquiry. Read 3 June 1808.
- Charles E. Coquebert de Montbret *'On examining the bottom of the sea'*. Letter to G.B. Greenough, 16 Feb 1816
- Charles Bathurst's *'Some account of the geology of the country between Stamford and Bedford'* (1826).
- Comte de Bournon's *'Memoire sur la Société Géologique de Londres'* With a covering letter to W. Babington [c.1808]

For information on the great significance of the Comte de Bournon's memoir see '*Chapter 1. The Creation'* in Herries Davies, Gordon L. *Whatever is under the earth: the Geological Society of London 1807 – 2007* (London: The Geological Society, 2007).

The total sum needed to restore this item is £2500. Donations of any size are welcomed gratefully to help us reach this target!

We are only £85 away from the total needed to conserve *'Oeuvres de Bernard Palissy, revues sur les exemplaires de la bibliothèque du Roi'*, by Bernard Palissy (1510?-1590). This edition, published in 1777 with notes by Barthélemy Faujas de Saint Ford and Nicolas Gobet, was presented to the Society by George Bellas Greenough.

Please contact Michael McKimm for more information. michael.mckimm@geolsoc.org.uk / 020 7432 0999



EMpower
Lecture Programme 2009

The Geological Society

8 October – University of East Anglia
Legacy liability research challenges at the Atomic Weapons Establishment Laura Peacock, AWE Aldermaston

13 October – University of Leeds
Science and Technology at Sellafield
Mike James, Sellafield

29 October – University of Edinburgh
Research & development challenges and decommissioning
Graham Fairhall, National Nuclear Laboratory

4 November – Lancaster University
Regulating the build of new nuclear power reactors
Dave Watson, HSE – Nuclear Installations Inspectorate

12 November – Imperial College, London
Opportunities & challenges of nuclear new build
Jeremy Western, British Energy – part of EDF Energy

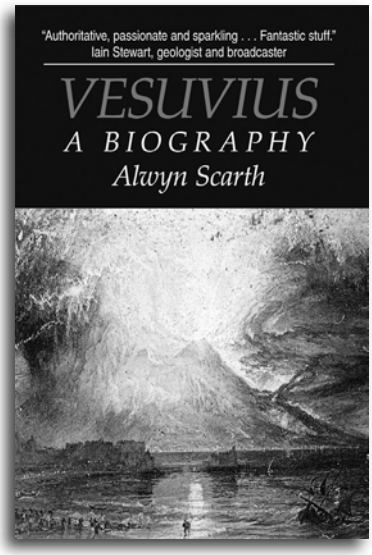
26 November – Cardiff University
Regulating risk we can't see – how we use science to protect the environment from radiation
David Copplestone, Environment Agency

Sponsor: Environment Agency

www.EMpowerinfo.org

Vesuvius: a Biography

Alwyn Scarth



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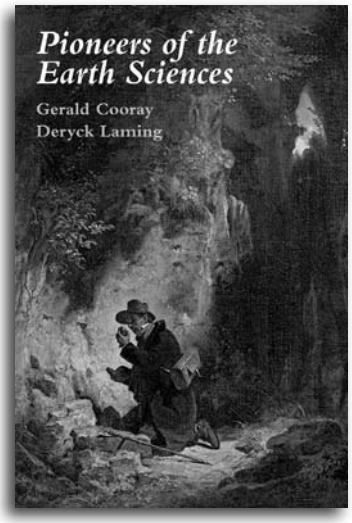

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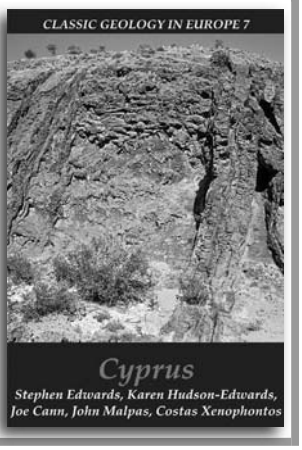

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SEPTEMBER 2009

•2-4 September – *Biogeochemistry of Marine Waters and Sediments, Present and Past.* Venue: Burlington House. This meeting brings together for the first time special interest groups in the Challenger Society for Marine Science (Marine Biogeochemistry Forum) and the Geological Society (Marine Studies). This joint meeting will focus on ocean acidification, palaeoproxies, particle inputs to the upper ocean (SOLAS) and polar biogeochemistry. Register now online at www.geolsoc.org.uk. **Contact:** Georgina Worrall, The Geological Society, Burlington House, London W1J 0BG. T: 020 7432 0983 F: 020 7494 0579 E: georgina.worrall@geolsoc.org.uk

•6-13 September – Fermor Meeting 2009: Supercontinents, Superplumes and Scotland. Conference & field trip. Venue: University of Edinburgh. The 2009 meeting and field trip will focus on the formation, configuration and break-up of Rodinia. Followed by a four-day field trip to see some fabulous and classic geology in the Western Highlands of Scotland. Full details and registration: www.geolsoc.org.uk/gsl/events/listings/page4772.html **Contact:** Alys Hilbourne E: alys.hilbourne@geolsoc.org.uk

•8 September – *Jubilee Symposium on Polymer Geogrid Reinforcement.* Hosted by the Institution of Civil Engineers and supported by the Engineering Group, this symposium will celebrate 25 years of research in polymer geogrid research and development. Venue: ICE, One Great George Street, London. Contact: Michelle Lee(organising Cttee.,)T: +44 (0)1254 262431 E: info@jubilee-symposium.co.uk

Southern Regional **•8 September** – *Contaminated Land* (Provisional) –Meet 6pm for 6.30pm Venue: Bell Inn, Godstone, Surrey. **Contact:** Sarah Cook T: 01342 333119 E: scook@southerntesting.co.uk

•9 September – *Shell London Lecture Series: The fossil record since Darwin.* Speaker: Richard Fortey. Venue: Burlington House. Matinée performance 3pm. Evening at 6pm – please note that if you would like to attend, the 3pm performance generally has more availability. **Contact:** Alys Hilbourne, Geological Society, Burlington House, London W1J 0BG T: 020 7432 0981 F: 020 7494 0579 E: alys.hilbourne@geolsoc.org.uk.

•15 September – *Site Investigation: Where Are We Now And What Is The Future?* Following from the significant changes to the regulatory landscape in the UK, this seminar offers the opportunity to understand the key effects on site investigation practice from the changes to both the SISG documents and the latest on the Eurocode. Venue: Burlington House. **Contact:** Patrick Cox, Capita Symonds Ltd. T: +44 (0)1342 327 161 E: patrick.cox@capita.co.uk

South West Regional **•16 September** – *Tasting of Wines from France - a Geological Perspective.* Venue: Boniface Centre, Crediton, 7.00pm. (Parking available. Venue close to public transport links from Exeter) **Contact:** E: swrg@geolsoc.org.uk.

•16 September – *Exploration Managers' Lunch Series.* Venue: The Napoleon Cellar (Berry Bros. & Rudd), St James's St., LONDON. Arrive from 12.00 for lunch at 12.30. **Contact:** Steve Whalley, Geological Society, Burlington House, London W1J 0BG. T: 020 7432 0980 F:020 7494 0579 E: steve.whalley@geolsoc.org.uk

Yorkshire Regional **•16 September** – *Contamination.* Venue: The Adelphi, Leeds. Buffet at 6pm for 6:30pm. **Contact and speaker:** Katie Dunn E: katie.dunn@WorleyParsons.com

South West Regional Devonshire Association **•19-26 September** – *Field Trip to Brittany, France.* Led by Dr John T Renouf. Must be pre-booked – please **contact** marcgreg@breathe.com.

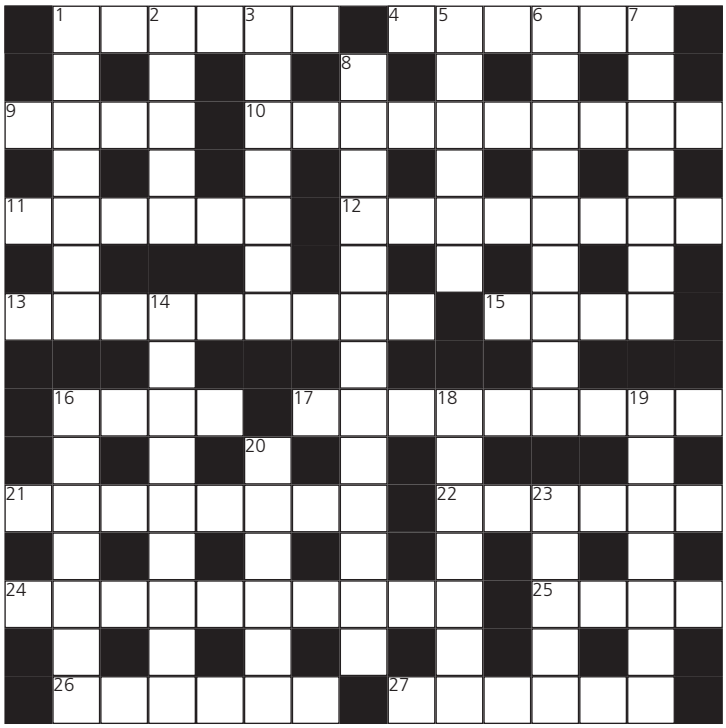
•21-23 September – *William Smith Meeting 2009: Environmental Pollution and Human Health.* Venue: Burlington House. This conference aims to bring together "traditional" geoscientists (geochemists, hydrogeologists, engineers, geophysicists, mineralogists) and scientists outside traditional Earth sciences (toxicologists, microbiologists, physicists, chemists) from both academic and industrial communities in the understanding of environmental pollution and the potential threats to human health. The meeting may also act as a forum for research projects supported under the joint NERC *Environment and Human Health* programme. Full details and registration: www.geolsoc.org.uk/gsl/events/listings/page4598.html **Contact:** Alys Hilbourne E: alys.hilbourne@geolsoc.org.uk

•24 September – *Contingent Resources: Will they ever make it to Reserves?* Venue: Burlington House. 6.00pm for 6.30. Register online at www.geolsoc.org.uk. **Contact:** Steve Whalley, Geological Society, Burlington House, London W1J 0BG. T: 020 7432 0980 F:020 7494 0579 E: steve.whalley@geolsoc.org.uk

•28-29 September – *Nuclear Waste Management: Research Challenges for the Future.* Venue: Fitzwilliam College, Cambridge. **Convener contact:** Ian Farnan (University of Cambridge) E: ian.farnan@esc.cam.ac.uk Office contact: Georgina Worrall E: georgina.worrall@geolsoc.org.uk

For meetings information always visit www.geolsoc.org.uk - full, accurate, up-to-date details

Crossword no. 127 set by Platypus



Solutions July:

Across: 1 Coking **4** Barite **9** Maar **10** Plagiarise **11** Septet **12** Airedale **13** Escalator **15** Tarn **16** Fume **17** Etiquette **21** Headwall **22** Axioms **24** Challenger **25** Floe **26** Trojan **27** Stereo

Down: 1 Craters **2** Karst **3** Naphtha **5** Apiary **6** Irradiate **7** Epsilon **8** Palaeontology **14** Armadillo **16** Freshet **18** Quadrat **19** Tombolo **20** Galena **23** Infer

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The winner of the July Crossword draw was **Jonathan Wilkins** of Deganwy.

All correct solutions will be placed in the draw, and the winner's name printed in the November 2009 issue. The Editor's decision is final and no correspondence will be entered into. Closing date – 15 September.

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Across

1 From Porthallow to Mullion, the best exposed ophiolite complex in the UK (6)
4 Atlantic volcanic island chain atop triple junction of N. American, African and Eurasian plates (6)
9 Much interrupting son of Judah (4)
10 Imbued with the mature features of a gender (10)
11 That which (you hope) ends up exclusively in the tailings (6)
12 Characteristic of compounds with same chemical formula but different molecular structure (8)
13 Lies between the Buntsandstein and the Rotliegend (9)
15 Thin mist covers student initiation (4)
16 Examine minute spaces very carefully (4)
17 24-hour rhythm (9)
21 Optical/chemical feature of a crystal that grew from solutions of changing chemistry (8)
22 Often grand, high-ranking official to a Muslim monarch (6)
24 That which 9 across refused to be to Tamar, widow of Er (10)
25 Defunct union of republics (1,1,1,1)
26 Disciples of Florence Nightingale (6)
27 Chemicals derived from an oxoacid and a hydroxyl compound (6)

Down

1 Ancestral descent (7)
2 He who in 1935 defined the convex object shape classes now named for him (5)
3 To feel or show esteem for (7)
5 Fanatic (6)
6 Sections of this region bordering Belgium were annexed from Germany by the Treaty of Versailles. Nazi Germany remilitarized it in 1936 (9)
7 Unable to produce viable offspring (8)
8 Sufferer from apodysophilia (13)
14 Heaven for believers (they think) (9)
16 Polypeptide compound made of amino acids in a linear chain (7)
18 Pores in rock big enough to get a man into (7)
19 Name of technique designed to prevent infection (7)
20 Penile hypocoristic (6)
23 Rock mushroom (5)

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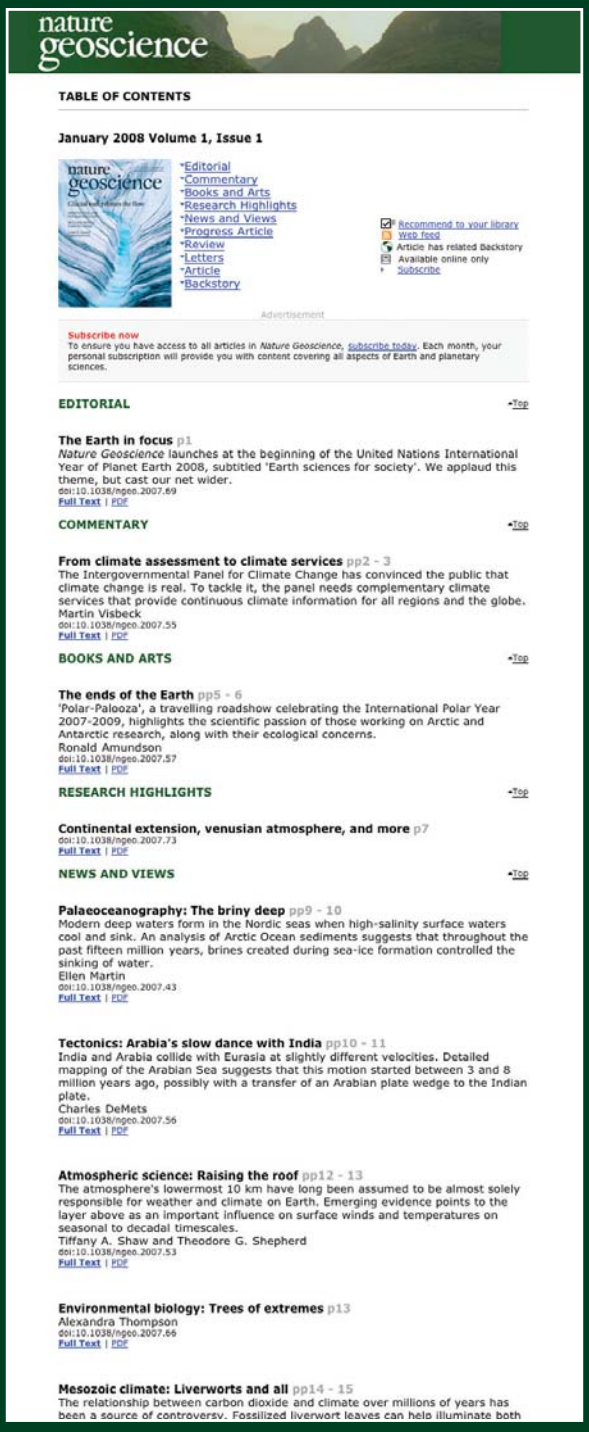

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