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Quaternary AUSTRALASIA

- INQUA: THE CONFERENCE; THE FIELD TRIPS
- OZPACS DATABASE: RECENT IMPACTS ON AUSTRALIAN ECOSYSTEMS

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Quaternary AUSTRALASIA

COVER The Southern Alps, INQUA post-conference field trip to South Island, New Zealand. Photo: Tim Barrows.

BELOW A collapsed section of lava tube with basalt rubble and colonisation by dry rainforest in the sheltered areas, Undara lava tubes, north Queensland. The Undara volcano erupted approximately 190 ka, creating lava tubes along existing drainage lines, and was the destination for one of the INQUA conference field trips.
Photo: Kerrie Tomkins.

Editorial

Dear Fellow Quaternarists,

It's amazing what a large international conference can do for improving communication and relations, not only between international scientists, but also within the local community. INQUA 2007 provided a wonderful opportunity to do just that, within our backyard. It was an intense week of science and meeting new people (and familiar colleagues), and for those of us for whom this was our first experience of a major international conference, it certainly broadened our horizons.

An additional advantage to holding the INQUA congress locally was of course the opportunity to showcase the fascinating Quaternary environments of the Australasian region through field trips, held in New Zealand, Papua New Guinea, and across the Australian continent. These field trips, and those which were held in the Cairns region during the conference, exposed both international and local visitors to the interesting and significant research being undertaken in our region. This issue contains reports on several of the field trips associated with the conference, many of which include snapshots which might make us wish we had been able to attend all of the trips on offer. David Lowe has also written a report on the INQUA Congress itself, and Julien Louys reports on the session on vertebrate communities.

Several of the reports in this issue were provided by the postgraduate students who were supported by AQUA to attend the conference. Thanks must go to AQUA for this support, and to the INQUA 2007 organising committee for its tremendous effort behind the scenes to make the conference as successful as it was.

Congratulations must go to Chris Turney for his award of the inaugural Sir Nicholas Shackleton Medal by the INQUA committee; Matt McGlone provides the details on this extraordinary achievement, which reflects the high standards of Australasian Quaternary science.

This issue also includes a paper by the OZPACS network members, which discusses a recently released database on palaeoenvironmental work relating to the last 500 years and implications for future research. Sander van der Kaars reviews a new book on pollen species, and Simon Haberle comments on ARC success in Australia.

This year has also been tinged with sadness for the Australasian Quaternary community, which recently lost two highly regarded scientists, Geoff Humphreys and Colin Vucetich. We pay our respects to our late colleagues in this issue.

Best wishes

Kathryn Fitzsimmons

President's Pen

Dear Quaternarists,

I can truly say that the INQUA 2007 Congress was one of the best conferences I have attended in a long time. Cairns provided a magnificent tropical backdrop to the event. The atmosphere at the conference was relaxed, and the persistent warm weather impressed our overseas visitors. The conference centre itself was great (although it was hard to find a cool drink outside regular watering times). The science was excellent and the keynote speakers well chosen and nicely dispersed throughout the program. A full conference report is provided by David Lowe in this issue.

A personal highlight for me was the AQUA special symposium, where I had the honour of presenting a Lifetime Membership to Professor John Chappell (also INQUA 2007 Conference President) for his contribution to Quaternary Studies in the Australasian region.

The conference also highlighted the respected status of Australasian Quaternary scientists, several of whom were elected to INQUA posts. Professor Allan Chivas was elected President of INQUA and Professor Brad Pillans took on the position of President of the INQUA commission on Stratigraphy and Chronology. The inaugural Sir Nicholas Shackleton Medal for an outstanding young Quaternary scientist was awarded to Professor Chris Turney (see report from Matt McGlone). Australasian Quaternarists also hold important positions on the editorial panels of international journals; Professor Colin Murray-Wallace is Editor-In-Chief of Quaternary Science Reviews, and Professor Rainer Grün is Editor-In-Chief of the new journal Quaternary Geochronology. Congratulations to all!

It was especially good to see so many postgraduate students attending and presenting at a large conference like INQUA. All the organisations that supported students to attend are to be commended for their important investment in the future. Thanks to conferences like INQUA, international networking is made so much easier.

Most importantly, however, the event was made possible by the INQUA 2007 organising committee. They must be thanked for investing so much time and effort into making INQUA 2007 such a huge success.

Finally, the ARC analysis by Simon Haberle in this issue shows a healthy outcome for Quaternary Science.With all our energy (and money) absorbed by the INQUA 2007 conference, the AQUA Executive has decided to organise the next Bi-Annual Meeting in South Australia (Coorong area) in December 2008. The Annual General Meeting for 2008 will be held as part of the 4th AINSE Quaternary Dating Workshop at Lucas Heights on Wednesday 27th March 2008.

All the best for the festive season and I hope to see many members at either the AGM or the Bi-Annual Meeting next year.

Yours Quaternarily

Henk Heijnis

The OZPACS database: A resource for understanding recent impacts on Australian ecosystems

Kathryn E. Fitzsimmons, Peter A. Gell, Sophie Bickford, Timothy T. Barrows, Scott D. Mooney, Tim P. Denham, OZPACS Convenors

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OZPACS Convenors: Stephen Gale, Adriana García, Simon Haberle, Gary Hancock, Jennifer Harrison, Tara Lewis, Nicholas Porch

Summary

The OZPACS project is a working group which aims to improve understanding of the human impact on Australian ecosystems over the last 500 years. One of its major outcomes is the creation of a database of existing research relevant to the period of interest, which can be applied to assess baseline environmental conditions and identify drivers of environmental change. This work is intended to assist and improve communication between researchers and natural resource managers. We report on the OZPACS database, which comprises metadata relating to various analytical methods, site locations presented in GIS format, a searchable reference list, and raw data from published studies. This work highlights the spatial and temporal bias of existing studies, and can therefore also be used to assist in plans for future research.

Introduction

OZPACS is a working group within the ARC-funded Environmental Futures Network. It is modelled on the goals of IGBP PAGES Focus IV – Past Human-Climate-Ecosystem Interactions (PHAROS), which seeks to integrate palaeoecological studies with monitoring and modelling to understand the relative contributions of human impact and natural climate variability in shaping natural systems. This aim to understand the functioning of present and future ecosystems is central to OZPACS, which actively focuses on giving an historical context for natural resource management by providing baseline conditions and tracing trajectories of environmental change. In 2008, OZPACS intends to introduce the database, and the evidence for environmental change contained within it, to natural resource managers. It will also provide an assessment of the state of Australia's ecosystems within a longer term context. In addition to this and its networking role, one of the principal aims of OZPACS is to assemble both unpublished and published short term palaeoenvironmental studies into a searchable database.

Palaeoenvironmental studies relating to the last 500+ years have been carried out at more than 500 sites across Australia. The OZPACS project, therefore, presents an ideal opportunity to improve our understanding of recent human impact on Australian ecosystems. As such the database is a major outcome of the OZPACS project and a significant legacy of the ARC-funded Environmental Futures Network.

This report provides a summary of the database, highlighting its potential as a resource for palaeoenvironmental studies of the recent past. The database also facilitates critical analysis of past work and emphasises the spatial and temporal bias of such studies. The full database is available online through the AQUA website (http://www.aqua.org.au/Archive/OZPACS/OZPACS.html).

The OZPACS database

The first major OZPACS workshop was held at the Australian National University in April 2006 (Gell et al., 2006), with another held at ANSTO in February 2007. Discussions held during these meetings resulted in the creation of a formatting and access framework for the database.

Metadata and reference list

The OZPACS participants outlined a set of field codes for individual metadatasets relating to different fields of study. Field codes include study locations, sampling sites, location coordinates, age range and control, analytical methods and relevant references. This framework was arrived at independently of similar international efforts associated with IGBP PAGES Focus IV, but contains close similarities in content and structure.

Individual metadatasets were compiled for different aspects of the database by designated convenors (Table 1). This information was compiled from work undertaken by the convenors and their colleagues, and from literature reviews completed by the convenors. The metadatasets were edited to comply with the field codes defined at the meetings. Relevant analytical methods varied between metadatasets. In total, the full dataset contains reference to more than 500 study sites and 490 publications.

References from the metadatasets were listed

Metadataset	No. sites	Contributor(s)	Comments
Charcoal	136	*Scott Mooney*	Includes raw data
Charophytes	4	*Adriana García*	
Diatoms	161	*Peter Gell* Kathryn Taffs Krystyna Saunders	
Geochronology	100	*Gary Hancock* *Jennifer Harrison* Kathryn Fitzsimmons	Incorporates ^{210}Pb, ^{137}Cs, radiocarbon and OSL dating studies
Invertebrates	15	*Nicholas Porch*	
Macrofossils	32	*Tara Lewis*	
Pollen	203	*Simon Haberle* Matiu Prebble	Uses data from Indo-Pacific pollen database (coordinated by Geoff Hope)
Sedimentation	7	*Stephen Gale*	
Archaeology	-	*Tim Denham*	Isochrones; presented as maps

Table 1: Summary of OZPACS metadatasets, including the number of sites and contributors (convenors in italics).

in an Endnote file. Each entry included keywords to provide search capability, and URL links where available. Currently the bibliography contains 490 references. A list of keywords, relating to sites and analytical methods, is available online along with the Endnote and rich text versions of the reference list.

GIS

Study sites were listed in an index and were designated identification numbers for cross-reference. This information is provided online as part of the database. Individual study sites for a given metadataset were plotted with their identification numbers onto maps of Australia and surrounding waters in GIS format, and are available online. Enlarged maps of areas with high densities of study sites are also provided for relevant metadatasets. A map displaying all study sites, with designated symbols for each metadataset, is shown in Figure 1 and is also viewable online.

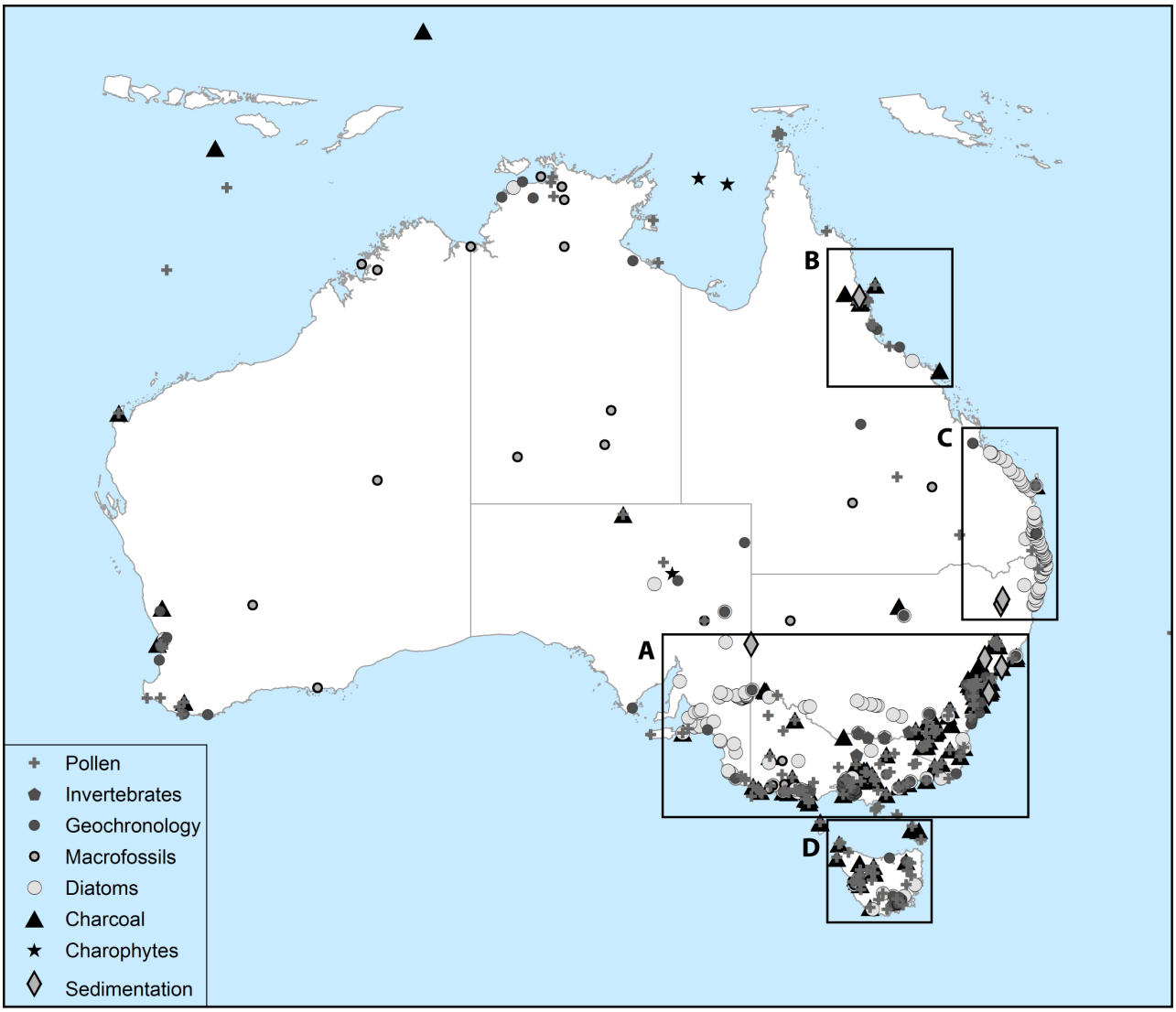
Spatial distribution of metadatabase sites

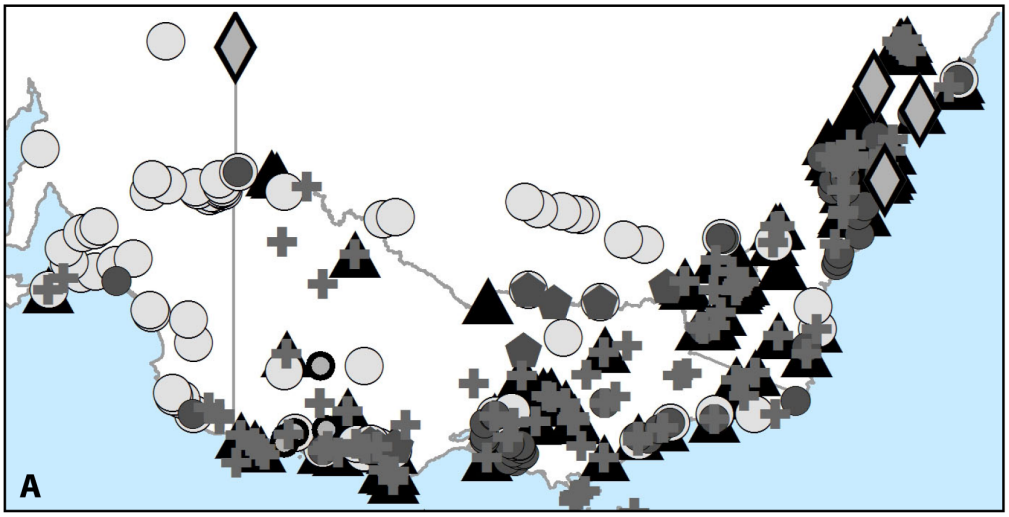
As can be seen in the map of Australia in Figure 1, the distribution of study sites relevant to OZPACS exhibits a strong bias towards southeastern Australia (including Tasmania) and the eastern seaboard of the continent. This bias is noticeably dominated by charcoal, diatom, pollen and geochronological studies; these studies also have the greatest numbers of sites, with at least 100 sites each (Table 1). Studies of invertebrate proxies are also concentrated in the southeast of the Australian mainland. The greatest concentration of sites occurs in Victoria, Tasmania and the southeastern quarter of New South Wales. The high density of sites on the east coast of Australia – in northern New South Wales and southern Queensland – is dominated by 63 diatom (palaeolimnological) studies by Kathryn Taffs and others. The concentrated distribution of sites in the southeast corner of South Australia is primarily attributed to diatom studies by Peter Gell and others.

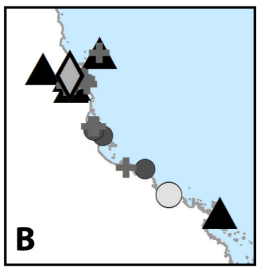
A cluster of sites in tropical north Queensland consists mostly of palynological and charcoal studies, although several sites in the Atherton Tablelands region have been the subject of multiple proxy analyses (e.g. Haberle, 2005; Haberle et al., 2006).

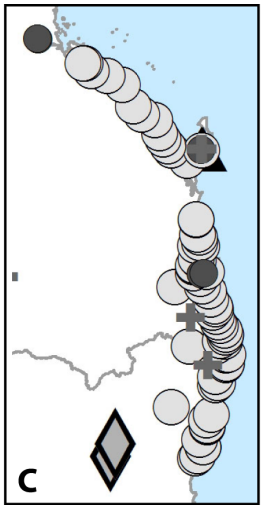
Sites from the macrofossil and charophyte metadatasets appear to be more widely distributed than those described above, although fewer sites comprise these metadatasets.

The most obvious conclusion that can be derived from the distribution of sites relevant to the OZPACS project is that studies thus far have been biased towards southeastern Australia. Much the same bias was identified and commented upon more than two decades ago during the CLIMANZ meetings (Chappell and Grindrod, 1983), and despite the fact that CLIMANZ was interested in a substantially longer period of time than OZPACS concerns itself with, it is worthy of note that









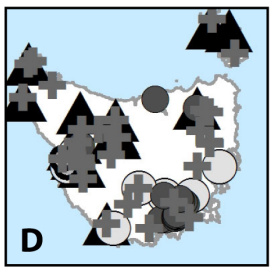


Figure 1: Maps showing the distribution of study sites for all OZPACS metadatasets. Insets:
A. Southeast Australian mainland
B. Tropical North Queensland coast
C. Southern Queensland and northern New South Wales coast
D. Tasmania

this spatial bias persists to this day. The distribution broadly reflects that of Australia's population. In terms of OZPACS' aim to improve understanding of human impacts on ecosystems subsequent to European arrival on the continent, this distribution may have some validity. It may also be worth noting that the distribution of sites similarly echoes the locations of institutions active in this research field.
However, this spatial bias represents a knowledge gap for large areas and a range of ecosystems across the continent. If researchers are to rigorously assess and document ecosystem change through time, including gaining a thorough understanding of baseline conditions, this spatial bias should be addressed. The OZPACS database, in this way, highlights potential target regions for future study.

Raw Data

Lake Euramoo on the Atherton Tablelands in northern Queensland has been identified by OZPACS contributors as a site of particular interest for understanding recent human impacts on ecosystems. The site has been the subject of multiple analytical techniques targeting the period of interest to OZPACS (Haberle et al., 2006), namely studies of charcoal, diatoms, invertebrates, macrofossils (macrofauna), pollen, sedimentation/magnetic susceptibility and dating using ^{14}C, ^{210}Pb and ^{137}Cs. Raw data from the original palynological studies of Kershaw (1973) at Lake Euramoo are included online.

Geochronological data and temporal bias

In addition to raw data for the Lake Euramoo site, key references which presented radiocarbon dates were used to create a database of (uncalibrated) radiocarbon dates between 1000-0 yr BP. All available information relating to the samples is included within the database, which includes 97 entries from more than 50 sites. Figure 2 shows a probability distribution plot of the 77 radiocarbon dates within this database which include error values. Twenty samples were listed within the publications as modern (a qualitative age implying <200 yr BP), or were not given error values; these samples were therefore not able to be included in the probability distribution plot. The plot represents the normalised sum of probability distributions of the individual dates and their uncertainties, and illustrates the temporal distribution of previous studies of interest to the OZPACS project.

The probability distribution plot shown in Figure 2 shows a clear decrease in the number of radiocarbon dates less than 200 yr BP. This may reflect the reduced reliability and relative precision of radiocarbon dating for samples younger than 200 yr BP, and the subsequent qualitative description of "modern" given to such samples. The limitation of the technique for the period within the last 200 years reduces our ability to reconstruct past environments during this critical time slice.

Our understanding of the youngest sediments may be improved through the use of alternative dating methods such as ^{210}Pb and ^{137}Cs. The references within the OZPACS database contain more than 100 age estimates using these techniques. However, the temporal limitation of these techniques leaves a significant gap in geochronological data between approximately 200-150 yr BP in the case of ^{210}Pb, and between 200-50 yr BP for ^{137}Cs (Walker, 2005).

OSL dating has the potential to address the gap in geochronological data, since this technique can be used to date sediments from a variety of contexts, ranging in age from close to zero to hundreds of thousands of years. Furthermore, the use of statistics in the estimation of uncertainties can reduce the precision of age estimates to less than 10% (Rhodes et al., 2003), which is useful for dating very young sediments at high resolution. One disadvantage, however, is that the technique is relatively labour intensive, resulting in fewer ages per unit effort. There were too few OSL age estimates in the geochronology metadataset to create a meaningful probability plot for the time period of interest. This in itself highlights the potential for OSL dating to be applied to sediments deposited during the last 500 years.

Overall, there is a significant temporal bias towards older and youngest dates from the available data. This bias may be due to sampling strategies and techniques adopted, since OSL dating can be applied to sediments less than 200 years in age, and ^{210}Pb dating can be applied to the last 150 years. This particular period coincides with European settlement and major changes in land use, and is therefore critical to the understanding of recent human impact on Australian ecosystems.

The temporal knowledge gap identified here represents an opportunity to improve our understanding of this period through targeted dating efforts of the younger stratigraphic units likely to represent recent environmental change. The use of OSL dating should be further exploited, particularly in environmental contexts which are not conducive to radiocarbon dating such as areas with limited organic material and rapid accumulation rates.

Conclusion

The OZPACS database assembles metadata from more than 500 sites across Australia relating to the last 500+ years. The metadata and accompanying maps, as well as searchable list of references, represent a valuable resource for improving our understanding of recent human impacts on Australian ecosystems. The interactivity of the GIS and database will be improved during 2008.

The database also clearly highlights some of the limitations of existing studies. It is significant that previous work exhibits spatial bias towards southeastern Australia, while large regions of the northern, western and central parts of the continent are virtually unknown. Likewise, there is a noticeable temporal bias in geochronological data towards very young sediments and those older than 200 years, leaving a period with limited age constraints between 200-150 yr BP – a period coinciding with European arrival and major environmental and land use change. The identification of these knowledge gaps aids plans

for future research, including targeting particular areas and stratigraphic units for palaeoenvironmental and geochronological studies.

The OZPACS Working Group will be meeting in December 2007 at the University of Adelaide to discuss the future directions of the network. Further expansion of the database is planned, which will include the addition of recently completed research and associated study sites and references to the metadatasets, and the addition of raw data from already published studies. Additional contributions of references and raw data relevant to the focus of the OZPACS project are invited. The existing database provides a framework for further study and the review of research undertaken in each field. This output is intended to form the basis of future publications from OZPACS project contributors, the scope of which will be discussed at the December meeting.

Acknowledgments
OZPACS is a Network Working Group funded through the ARC-funded Environmental Futures Network. Thanks go to the many contributors to the OZPACS database and bibliography, and to participants at the workshops where the aims of the project were discussed.

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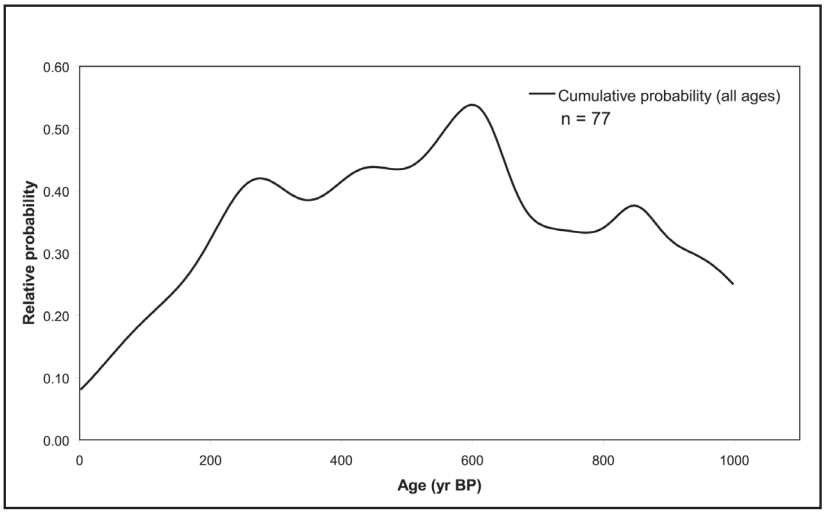
Figure 2: Cumulative probability distribution plot of published radiocarbon dates within the last 1000 years, as recorded in the online OZPACS radiocarbon database.



INQUA Comes To Cairns

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Introduction

Around 1000 multidisciplinary scientists, including more than 40 from New Zealand and 200 from Australia, gathered in Cairns from 28th July–3rd August, 2007, for the four-yearly conference of the International Union for Quaternary Research (INQUA), the 17th such congress since INQUA's founding in 1928. The meeting, convened by Professor John Chappell of ANU and his committee – drawn from members of host organisation, the Australasian Quaternary Association (AQUA) – was only the third to be held in the Southern Hemisphere, the previous two being in Durban (1999) and Christchurch (1973). The choice of Cairns was an excellent one: it is a very pleasant, compact, historically interesting, and user-friendly city. The winter weather was perfect throughout the meeting.

Conference features: field trips, oral and poster papers

The congress was held in the impressive Cairns Convention Centre over five days, with a sixth set aside for local one-day field excursions (four were offered) including to the Atherton Tablelands and the Great Barrier Reef. Around thirteen pre- and post-congress trips also ran. One post-congress field trip (six days) to New Zealand's South Island, organised by Dr Peter Almond and PhD student Fiona Shanhun of Lincoln University, attracted 29 international (dominantly Northern Hemisphere) participants and was a great success. Additional tour leaders with Peter and Fiona included Jamie Shulmeister (University of Canterbury), David Barrell (GNS, Dunedin) and Marcus Vandergoes (GNS, Lower Hutt). Two pre-congress North Island, New Zealand, field trips had been planned in some detail but were reluctantly cancelled in late February because numbers of potential participants at that time were not viable. The trip to the Huon Peninsula was cancelled because of logistical problems in Papua New Guinea.

Because nearly 1600 abstracts were offered, the conference schedule was very busy with nine concurrent sessions operating at most times, beginning each day at 8 am sharp. A drawback of the otherwise excellent venue was that at times the rooms available for the concurrent sessions were too small, most with seating capacity for only about 50-70, and frequently audiences amounting to possibly 100 or more attempted unsuccessfully to squeeze in to them. Part of the problem of such a tight schedule arose because some people gave more than one oral paper, although the organisers tried to restrict oral papers to a maximum of two per person (previously it has been one).

The papers were organised into 70 themes or symposia, which were typically split into several sessions over several days. At times 'left overs' from one symposium were spliced on to those of another to make up the right numbers for a complete session, some of which consequently ended up with rather odd combinations. At times, the sessions were too long with eight or even nine papers delivered without a break. Most oral papers in each theme were of 15 minutes duration, including questions, but symposium convenors were able to invite two keynote speakers, who each had up to 30 minutes. A frustration of the conference was that almost inevitably there was insufficient time for more than just one or two 'quick questions' at the conclusion of each talk – usually because speakers pushed time limits to the maximum.

I counted numbers of papers per person as listed in the 486-page abstracts volume (published as *Quaternary International* Volume 167-168 Supplement, July 2007) and found that 31 people who each co-authored seven papers or more accounted for 286 papers between them. One, the very energetic David Fink (ANSTO), took first place as a co-author on 22 papers, F.H. Chen was second with 16 papers, and M. Leng third with 15 papers, followed by 13 papers (two people), 12 papers (one person), 11 papers (two people), 9 papers (one person), 8 papers (10 people), and 7 papers (12 people including yours truly).

The Powerpoint set-up at the centre was superb and the technical staff who ran it very helpful, friendly, and expert. The internet 'café' (definitely minus the coffee, a severe problem for some of us at 8 am), with around 20 laptops available free of charge, was in use virtually from 8 am until the convention centre closed its doors at 8 pm. The convention support staff who provided food and refreshments were extremely well presented as were the meals and teas.

Five poster sessions were run with several hundred posters in each. Two sets of posters were each displayed for two or three days. A problem with the initial poster session, where authors were to stand alongside their posters to discuss them, was that the boards were placed too closely together; traffic quickly ground to a standstill (I struggled to actually reach my poster). The problem was alleviated later by dispersing the posters more widely.

Plenary papers

Eight plenary papers were given, including two by New Zealand speakers Professor Peter Barrett (Victoria University of Wellington), who spoke on "Antarctic climate history – distant past and near future", and Professor Alan Cooper (University of Adelaide), whose topic was "Innovations in Quaternary research – the power of ancient DNA for reconstructing late Quaternary biogeography". Other plenary speakers were Professor Gifford Miller (USA), Professor Stephen

Oppenheimer (UK), Dr John Pandolfi (University of Queensland), Professor Stefan Rahmstorf (Germany) (Stefan undertook his PhD studies in New Zealand and worked for NZOI until the mid 1990s), Professor Chris Stringer (UK) and Professor Pinxian Wang (China). The plenary papers were without exception outstanding in content and presentation and a real highlight of the congress. I was deeply impressed by Miller's paper "Separating the impacts of climate change and human colonization on the flora and fauna of Pleistocene Australia", and it was a special thrill to see Stringer's talk "Origins and dispersal of pre-modern hominids". At the International Council, however (see below), a criticism was levelled at the conference organisers that the gender bias for the plenary talks, 100% male, was not appropriate in these times.

Sir Nicholas Shackleton Medal

A special feature of the congress was the presentation of the inaugural Sir Nicholas Shackleton Medal "for outstanding young Quaternary scientist" to Professor Chris Turney, who recently relocated from the University of Wollongong to a chair at the University of Exeter (UK). Professor Turney, who undertook his doctoral research at Royal Holloway, University of London, also worked in New Zealand at Landcare Research (Lincoln) as a postdoctoral fellow. As well as developing an outstanding scientific career including carbon dating "the Hobbit" *Homo floresiensis*, Chris has also given numerous talks to public groups and written a popular best selling book about time and dating: "Bones, Rocks and Stars: The Science of When Things Happened". He was listed as co-author on 11 papers at the conference, and seemed to be everywhere!

International Council

INQUA's International Council met from 2 pm to 6 pm on each of three days. A new Executive Committee for the next intercongress period (2007-2011) was elected as follows:

President: Professor Allan Chivas (University of Wollongong, Australia)

Vice-presidents: Professor John Lowe (UK), Professor Koji Okumura (Japan), Professor Alan Ashworth (USA) and Professor Margaret Avery (South Africa)

Secretary-general: Professor Peter Coxon (Ireland)

Treasurer: Dr Marie-France Loutre (Belgium)

Past-president: Professor John Clague (Canada)

The council also voted for the venue of the next conference, with bids from Edinburgh, UK, and Bern, Switzerland, being presented. By one vote, it was decided that the 2011 INQUA congress would be held in Bern. Professor Okumura stated that Japan was likely to prepare a bid to host the 2015 congress.

Reports on the activities of members of each of the five commissions of INQUA were received, the commissions being (1) Stratigraphy and Chronology (SACCOM) (led by Professor Brad Pillans of ANU); (2) Coastal and Marine Processes; (3) Palaeoclimate (PALCOMM); (4) Terrestrial Processes, Deposits, and History (TERPRO); and Palaeoecology and Human

Top: Entrance to the impressive Cairns Convention Centre. Photo: D.J. Lowe
Above: Part of the internet café during a quiet period. Photo: D.J. Lowe
Below: Chris Stringer, plenary speaker from the Natural History Museum, London. Photo: D.J. Lowe

Evolution (PAHE). One change made in Cairns was that the various subcommission groups prior to the 2007 meeting were discontinued as such and morphed into 'international focus groups'. In establishing such focus groups, INQUA aims to develop further its project-based approach. For example, in SACCOM, the Subcommision on Tephrochronology and Volcanism (SCOTAV) was renamed the International Focus Group on Tephrochronology and Volcanism (INTAV). INTAV still lies under the umbrella of SACCOM but has relevance to all the other commissions because of its inherent interdisciplinary character. INTAV will operate both as a separate group and will organise a specialist tephrochronology meeting in the intercongress period. INTAV will also work in collaboration with other focus groups within or beyond SACCOM, including contributing to the highly successful PALCOMM-based INTIMATE project examining the nature, timing and regional to global extent of climatic changes associated with the end of the last glaciation (e.g. Turney et al. 2006; Alloway et al. 2007).

Other points discussed included: (1) the acceptance of INQUA as a full scientific union member of the International Council for Science (ICSU), which provides INQUA with more international clout and the opportunity to consider taking on one or two very high profile projects; (2) the status of the term 'Quaternary', under intense debate for the past few years, is now formally defined as a System/Period; (3) the age of the base of the Quaternary, although currently set at 1.8 million years but widely accepted as being 2.6 million years, is to be debated and (hopefully) formalized at a meeting in Oslo in 2008; (4) encouraging greater representation of South American and African Quaternary scientists is to be a priority; (5) an INQUA 'distinguished career' medal (to accompany the Shackleton Medal) for leading Quaternarists is to be developed by the next executive; (6) greater funding to better facilitate project-based research is to be sought; (7) honorary members of INQUA (usually distinguished scientists near or in retirement, and nominated by member countries) were voted upon. I note in regard to point (7) that potential honorary New Zealand and Australian Quaternary scientists must be nominated at least six months before the next congress, and that only four had ever been so elected (Max Gage and Pat Suggate from New Zealand, and Jim Bowler and [in 2007] Martin Williams from Australia). It is time to consider nominating more in time for the 2011 meeting and in New Zealand we have drawn up a tentative list of potential nominees.

INQUA membership categories and subscription rates
The membership status of various countries, and the subscriptions for each, were revealed at Cairns to some embarrassment. There are eight categories:
Associate (no voting rights): South America (Argentina is to become a specific member country), East Africa (no subscription)
1A (low GDP countries): No countries (subscription rate for 2008-2011: €211)
1: Brazil, Chinese Taipei, Czech Republic, Denmark, Estonia, France, Hungary, Ireland, Israel, Latvia, Lithuania, Mozambique, New Zealand, Poland, Portugal, Republic of Korea, Serbia (€453)
2: Austria, Belgium, China, Finland, India, Norway, Spain, Sweden, South Africa, Switzerland (€1376)
3: Australia, Canada, Netherlands, Russia (€2293)
4: No countries (€3208)
5: Germany (€4584)
6: Italy, Japan, UK, USA (€8733)
It was noted (1) that these groupings are largely historical in origin, but should be reconsidered by the incoming executive, with some countries to be moved into new classes; (2) that New Zealand, Denmark, France, and Ireland and possibly some other countries should seriously consider moving up one or more classes and hence increase their contributions to INQUA, as one way of increasing INQUA revenue to enhance current or facilitate new projects and to support research in low GDP countries. I have brought this point to the attention of the Council of the Royal Society of New Zealand for consideration. My personal view is that INQUA should be supported by New Zealand certainly as a 'class 2' country (or perhaps 'class 3' alongside Australia).

Quaternary journals rise

I attended a meeting of the editorial board of *Quaternary International*, one of four 'pure' Quaternary journals published by Elsevier. The rise of impact factor scores for these journals was highlighted, especially the dramatic rise of *Quaternary Science Reviews* (4.113) which is now the second-ranked geoscience journal behind only *Annual Reviews of Earth and Planetary Science* (7.683) and ahead of *Geology* (3.477). The 2006 impact factor scores (based on citations and publications for 164 journals between 2004-2005) for these and other selected journals are as follows:

Quaternary Science Reviews (2): 4.113
Earth Science Reviews (3): 3.989
Geology (5): 3.477
Paleoceanography (6): 3.018
Journal of Paleolimnology (7): 3.016
Geological Society of America Bulletin (9): 2.820
Quaternary Research (18): 2.319
Global and Planetary Change (25): 2.060
The Holocene (30): 2.000
Journal of Quaternary Science (31): 1.906
Palaeogeography, Palaeoclimatology, Palaeoecology (35): 1.822
Boreas (36): 1.812
Geomorphology (42): 1.698
Journal of Volcanology and Geothermal Research (43): 1.685
Quaternary International (45): 1.607
Journal of Archaeological Science (59): 1.322
Progress in Physical Geography (66): 1.278
Australian Journal of Earth Sciences (78): 1.000
NZ Journal of Geology and Geophysics (103): 0.822

INQUA has an association with Elsevier such that it receives 25% of the profit derived from the publication of its flagship journal, *Quaternary International*. The return in 2007 (for sales in 2006) was a record €56,000, and parallels the journal's growing status.

Conclusion

I congratulate the Australian Quaternarists and others for organising and running a most informative, stimulating, and enjoyable conference. Undertaking such a task represents a massive effort and commitment. Apart from a few minor quibbles concerning the odd fragmentation of some sessions and rather small rooms for concurrent sessions, and the challenging programme layout, the conference was a terrific event. I had forgotten how intensive a large conference such as INQUA is, but I learnt a great deal about the latest developments in a wide range of disciplines and I very much enjoyed the relaxed ambience of Cairns and meeting many old and new friends. I was very honoured to be the New Zealand delegate on the International Council.

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Clockwise (from top right): Peter Kershaw (left) and Chris Turney, inaugural winner of the Sir Nicholas Shackleton Medal, answer questions about Lynches Crater. Maarten Blaauw (left) and Rewi Newnham at the conference dinner. Cinder cones of Seven Sisters group (>0.35 Ma) on Atherton Tablelands. Photos: D.J. Lowe

Report on the INQUA pre-conference field trip to central Australia

"Quaternary environments of South Eastern Australia" led by Professor Gerald Nanson and Kathryn Fitzsimmons

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One of the pre-conference field trips offered as part of INQUA 2007 was "Quaternary environments of South Eastern Australia", led by Prof Gerald Nanson (University of Wollongong) and Kathryn Fitzsimmons (Australian National University). The fieldtrip offered the opportunity to view some of Australia's most iconic landscapes while discovering the complex history of Quaternary climate in Australia, with emphasis on hydrology, dune formation and the transport of sediments and dust. Meeting in Mildura (NW Victoria) on July 19th, 26 scientists set out in a 22-seater bus and a 4-seater Hilux 4WD. Eight days and 2700 km later, 26 friends would arrive at Charleville in southern Queensland, crowded into the 22-seater bus with their dusty luggage dragging along behind in a worn-out trailer, armed with some good tales and practical experience of the dirt tracks, mallees and coolabahs, fluvial and aeolian sequences, dry channel beds and gibber pediments of eastern Australia.

On the morning of the 20th we headed north out of Mildura toward Lake Mungo, location of one of the most significant archaeological sites in Australia (Bowler et al., 1970; Bowler and Thorne, 1976). Before arriving at Lake Mungo, a brief roadside stop allowed us to find out why Mallee trees "mallee", or grow in a cone-shaped collection of branches rather than a central trunk, in semi-arid areas. We lunched near the western edge of the playa where a lookout enabled a view of the ancient lake shoreline and its lunette on the downwind marsh. Gerald invited us to imagine the dry, sparsely vegetated playa as it would have appeared 50,000 years ago - a verdant lake, well vegetated, populated by now-extinct megafauna and thriving aboriginal communities (e.g. Bowler et al., 2003; Kershaw and Nanson, 1993). We then visited the lunette on the eastern edge of Lake Mungo, north of the sites of earliest evidence of aboriginal habitation and ceremonial burial practices, discovered by Jim Bowler in the 1960's (Bowler et al., 2003). As the sun set, we traversed the lunette to view the eastward encroachment of active dunes onto cleared land and learn about the chronology of the lunette, which comprises three discrete periods of formation since MIS5. Over 100 ka of dune formation and stabilisation is being removed as the dune slowly migrates to the east over recently-cleared land. We were inspired to contemplate and debate the forces which transformed the landscape to its current state: drought, fire, the extinction of megafauna, in the light of Giff Miller's argument for human habitation of the continent as a driver of landscape change from 50 ka (Miller et al., 1999). Near sundown we continued on our way north to the Telegraph Hotel at Pooncarie.

On the morning of the 21st we walked down to the bank of the Darling River to see the effects of a drought which has gripped much of Australia for the past decade. The slow migration of the riverbanks in response to the dwindling flows of the river was emphasised by the exposed roots of century-old red gums. We had this image to ponder while travelling 250 km to the historic mining town of Broken Hill, famous for its rich lode of silver, lead and zinc. After some shopping and a coffee break we were back on the road: crossing the South Australian border to arrive at Erudina Station 600 km and a broken headlight (thanks to an errant kangaroo) later. A highlight of the field trip was the after-dinner lecture on the geology, Aboriginal linguistics and dreamtime stories of the local area, given by Erudina station owner John McEntee who impressed us with his enviable combination of knowledge, hospitality and humility.

The following day saw us cross the Flinders Ranges via the Brachina Gorge geological trail, famous for its remarkably exposed stratigraphy, late Pleistocene fine-grained valley-fill formations and the ancient Ediacara fossils first discovered there in 1946. Discussions revolved about the recent dating of the silty sediments (Glasby et al., 2007; Williams et al., 2001), dating strategies and the relative merits of palaeorecords constructed primarily from stratigraphic sequences compared to those primarily reliant on chronological markers. Another long drive saw us arrive by nightfall at Muloorina Station, 30 km from Lake Eyre South, where the hot showers are sourced direct from the groundwater of the Great Artesian Basin.

The 23rd saw the group heading to Lake Eyre to visit a 150 kyr palaeoshoreline sequence at Wilson's Point, described by Magee et al. (2004). We probed the silcrete caps, calcite layers and rootcast material on the lake palaeoshoreline, and others wandered out onto the dry lake surface. Debate again revolved around the palaeoclimatic history of the region, the various arguments for the sources of water to Lake Eyre during the late Pleistocene (enhanced southward influence of the monsoon and vegetation feedbacks vs. the warming of South Pacific surface waters and increased rainfall from easterly airmasses), and the evidence for the gradual southward migration of Lake Eyre: the

Figure 1. Participants of the INQUA 2007 pre-conference fieldtrip "InnamINQUA" at the Noccundra Hotel.

geomorphology of the southern edge of the playa as well as the remnants of lunettes to the north of the current limits of the playa.

Next morning we travelled back to Lyndhurst before setting out on the 370 km trek along the Strzelecki Track. Along the way we stopped to view the gibber pediments of the Strzelecki Desert – where stones had been mechanically transported to the surface by shrink-swell processes. For the last 200 km of the track we were surrounded by linear dunes, fine sand stabilised by low scrub vegetation that survives on the limited supply of water in the region. Just south of Innamincka we passed a demonstration plant for Geodynamics Ltd Hot Rock energy – tapping into the heat reserves of hot fractured granite 4 km underground. The presence of hot fractured rock so close the surface inspired debate regarding the future of central Australia – could it be the world's next great rift valley? Arriving at the town common on the bank of Cooper Creek, tents were quickly set up before retiring to the Innamincka Pub for dinner and a beer or three.

The first indication of trouble came in the morning, not at 5 am when we were woken by corellas screeching in the trees above our tents, but later when the fuel filter alarm sounded on starting the bus. After breakfast by the river we were on our way to Innamincka Dome to view the surrounding lie of the land and hear Gerald's description of the geomorphology and Quaternary history of the "Channel Country". The next site of interest was "Hesse" dune, within the Strzelecki Desert dunefields, where Kathryn explained some of her PhD research on the history of dune formation and their morphology in the area (Fitzsimmons et al., 2000). We continued on to Tilcha waterhole on Cooper Creek to see a 29 m sequence of aeolian and fluvial sediments (Coleman, 2002). Unfortunately, on the return journey the engine of the Hilux 4WD seized up and it had to be towed to Innamincka. Conversation turned to contingency plans on the second last dinner of the field trip but the mood improved as we celebrated and welcomed Kathryn into the fraternity of those who have submitted PhDs.

The next morning we learned that the Hilux could not be fixed, so all 26 of us would have to travel on the bus. On the way to the historic (1882) Noccundra Hotel, we stopped to discuss the sediment sources of the dunes we'd traversed – from the original protolith of the sediment in the Great Dividing and Flinders Ranges (Pell et al., 2000), fluvial transport of the sediment toward the centre of Australia and the aeolian deflation of that sediment during arid periods – and then to the transport of dust toward the edges of the continent and beyond, to the Tasman Sea, New Zealand, Southern Ocean and possibly also Antarctica. We were forced to stop when the smell of burning rubber was detected - one of the tyres had burst! After 45 minutes of frustration we had to accept that we couldn't change the tyre (the hubcap could not be removed!) so we continued on to Noccundra, slowly. The stop also revealed that the hinges connecting the door to the trailer were shearing off, so while one group was wrestling with the hubcap another was tying down the trailer with rope, string and duct tape! Our successful

arrival at Noccundra Hotel an hour later was met with sighs of relief and cries for beer. Dinner that night was celebrated in the dining room with a toast to Gerald and Kat.

So with a new tyre, fresh tape on the trailer and a moderate sense of anxiety, the final day of the field trip commenced at 4.30 am with Charleville airport 500 km away and our flights to Brisbane departing that same afternoon. That morning we avoided emu, kangaroos and wedge-tailed eagles as we drove eastward into the sunrise. The sensation of having completed a grand journey developed as we emerged from the outback: the land greening, scrub giving way to acacia trees then eucalypts, ephemeral creeks giving way to flowing rivers, dirt tracks leading to gravel roads and then to paved highway. From the confluence of the Murray and Darling Rivers we'd travelled northwest to the Lake Eyre basin depocentre, then northeast along the rivers which feed Lake Eyre, to eventually arrive at the head of the Darling River system. We stopped for snacks at Quilpie before arriving at Charleville airport with just two hours to spare: time enough to untape the trailer, beat the dust from our bags, empty the bus, make a sandwich from the last of our lunch supplies, and retire to the airport café while waiting for the plane to Brisbane.

Figure 2. Gerald Nanson describes the formation and chronology of linear dunes in the Cooper Creek basin.

Figure 3. Kathryn Fitzsimmons describes the stratigraphy of Hesse dune near Innamincka.

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Report on the symposium "Quaternary changes of vertebrate communities"

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The symposium on Quaternary changes of vertebrate communities ran over three sessions on Thursday 2nd August. Changes in vertebrate communities from Europe, Africa, North America, Asia and Australia were examined throughout these sessions. The first session began with examinations of the large-bodied mammalian record from Europe. Jean-Philip Brugal and Maria Palombo, in two interesting presentations, outlined the chronological and ecological changes occurring throughout the Quaternary of (mainly) Western Europe, attempting to tie these events with major climatic or intrinsic biotic events. In particular, these analyses are based on the progressive appearances and disappearances of vertebrate taxa throughout the Quaternary, an analysis made possible by the excellent vertebrate fossil record and associated chronologies existing in Western Europe. The remainder of the first session, while staying firmly on the European record, looked at more specific cases, whether site specific or taxonomic in nature. Andrea Villi, for example, presented a comprehensive description of cervid migrations, replacements, evolution and extinctions throughout Europe, while Gloria Cuenca-Bescos described the small mammal record from Atapuerca, an important hominid site in Spain.

The second session was significantly shorter, comprising only one presentation by James Brink. However, this presentation moved the focus to the African faunal record, examining turnovers of the large mammalian faunas, in particular from South Africa. The record presented by Brink shows increasing levels of endemism in South Africa during the Middle and Late Pleistocene, in association with increasing openness of the vegetative landscape. In particular, Brink shows that the end-Pleistocene extinction event was driven largely by acidification. These findings have implications for the global megafauna extinction debate. It provides a good example of large-bodied mammalian extinctions associated with climatic deterioration. The assumption by some researchers that the climatic fluctuations of the Pleistocene could not be responsible for any extinctions during this period should be reassessed in light of this finding.

The third, and last, session began with more research on the European record, but then moved on to the rest of the world. Haowen Tong presented an examination of the Chinese Quaternary large-bodied mammal faunas and their relationship with their African representatives. Tong suggests that many "typical" African species had a Eurasian origin, dispersing subsequently to Africa and Asia. Following their pre-Pleistocene origin, however, there appears to have been little interchange between African and Chinese large-bodied mammals, which Tong suggests is unsupportive of the classic "out of Africa" scenario for hominids. Certainly, the mammalian faunas associated with hominid dispersals have received a lot less attention than the hominids themselves, a pity considering the valuable information which they could yield. It is hoped that Tong's presentation will encourage further research in this area.

My presentation was concerned with the megafaunal extinctions in Southeast Asia. I presented a general overview of one part of my PhD project - the extrinsic factors associated with large-bodied mammal extinctions. I contend that of the three factors examined, humans, climate change and volcanism, climate change, and in particular changes in sea-level, have been largely responsible for their extinction. My findings certainly complemented those of James Brink earlier on in the day, and again the argument can be made that climatic changes in the Pleistocene were capable of driving at least some extinctions of large-bodied mammals.

The talks then moved south geographically, with a presentation by Scott Hocknull on the rainforest vertebrate communities in Australia, with a specific focus on the diverse Mt Etna faunas from the Middle Pleistocene in Queensland. Hocknull presented an intriguing analysis of the transition of rainforest faunas before and after human arrival. He described an extinction signal among Late Pleistocene large-bodied mammals, most likely a result of the entry of humans in Australia. However, he also described a faunal turnover among the large-bodied mammals during the Middle Pleistocene, albeit reduced in intensity relative to the Late Pleistocene. This fascinating observation is supportive of contentions by an increasing number of researchers (e.g. Barnosky et al., 2004, Wroe and Field, 2006) that the end-Pleistocene extinction event was in all likelihood the result of a complex interaction between climate and humans.

Jeremy Austin supplemented the plenary session presented by Alan Cooper earlier in the day by presenting an overview of ancient DNA research in Australia. The final presentation dealt with the microfauna of the western United States by Jenny McGuire. She presented research detailing the association between vole tooth morphology and geographically-driven changes in climate. These associations have important palaeoecological implications, especially if her findings are extended temporally through the Pleistocene.

The diverse presentations presented at this symposium provide a snapshot of the disparate approaches to vertebrate community changes during the Quaternary. However, any study of Quaternary vertebrate communities necessarily deals with similar issues specific to this geological period – namely the influence on, or implications for hominids; and the effects of, or implications for, the major climatic changes present during the Quaternary. These facets are in addition to their intrinsic value to studies of vertebrate palaeontology as a whole.

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INQUA mid-conference field trip report to Undara Lava Tubes

Tuesday 31st July, 2007

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The XVII INQUA mid-conference field trip to the Undara Lava Tubes explored some of the scenic landscapes of the McBride volcanic province in North Queensland. The Undara Lava Tubes were of special interest to us since they are the largest and finest examples of their kind in Australia and contain specialised ecosystems that are internationally significant. Peter Whitehead (our field trip organiser) also provided informative insights into the timing and processes of formation of the many remarkable volcanic features in the surrounding region.

Essentially, the Undara Lava Tubes were created around 190 ka ago when molten lava from the then active Undara volcano (elevation c. 1020 m ASL) flowed away from the crater along pre-existing drainage lines; mainly to the north (flow length c. 90 km) and north-west (flow length c. 160 km) (Atkinson et al., 1975). The Lava Tubes formed as the sub-aerial surface of the lava channels cooled and solidified, thereby insulating the remainder of the lava within the channels which continued to flow "downstream" due to the topography of the plains, and leaving behind a series of hollow tubes when the flows finally ceased (Atkinson et al., 1975). The Lava Tubes are well preserved in many places, and can be identified by caves, depressions and long, level ridges; however, they only make up a small proportion of the entire Undara volcanic field (total area c. 1,550 km^2; lava volume c. 23 km^3) (Atkinson et al., 1975).

Our excursion began with a leisurely (and fairly sinuous) drive from Cairns over the Gillies Range and through the rolling hills of the Atherton Tablelands. Cruising past relict volcanoes and their associated landforms we made our way to the quaint township of Ravenshoe (home to Queensland's highest altitude pub and pronounced "Ravens-hoe", not "Raven-shoe", we were warned!) where coffee and cake were provided for morning tea. We then proceeded north-west towards the Undara Volcanic National Park via the aptly named mining locality of Mount Garnet, past Mount Surprise and then through Forty Mile Scrub National Park. The open woodlands of the plain (with numerous termite mounds) gave way to open savannah as we neared the Undara Volcanic National Park, where the rich volcanic soils were covered with seasonal grasses and patches of remnant "dry rainforest". This National Park is located on the eastern edge of the Gulf Savannah, about 300 km south-west of Cairns by road (interestingly, we were also informed that "Undara" is an Aboriginal word meaning "long way"), and so upon our arrival we were grateful to stretch our legs in anticipation of what the exposed sections of the Lava Tubes in the area had to offer.

Following a buffet lunch which was provided by the Undara Experience Lava Lodge (a privately managed camping ground/lodge situated within the National Park), we proceeded out into the landscape with our Savannah Guides, sticking to the footpaths around some depressions and collapsed tube sections which were filled with distinctive savannah and "dry rainforest" vegetation (Photo 1). As we descended into the first collapsed section of the tubes we were struck by the dense evergreen foliage of the trees and vines, the reduction in temperature near the rubble-strewn mouths of the tubes, and by the size of the tubes themselves –in the order of 20 m wide and 10 m high in those sections (Photos 2 and 3). Inside another section of tube it was clear that we were not standing on the original lower lava surface and that silcrete had partly infilled the caves, leading to a progressively smaller tube area where the silcrete floor approached the tube ceiling further away from the collapsed section (Photo 4). Long tree roots also extended across the base of the tube near the opening into the collapsed sections, while some roots had actually penetrated through the ceiling of the tube and were seen hanging down into the cavernous void.

The internal walls and ceiling of the tubes were slightly weathered and displayed a rough-textured cooling surface with an array of colourful patterns (Photo 5), while areas where the ceiling had collapsed were characterised by smooth, more planar and less weathered surfaces. Well developed "cave corals" had also formed in some sections of the tube ceiling due to the cementation of mineral salts in ribbon-like arrangements. There were numerous examples of lava flow levels still visible along the walls of the tubes (Photo 6), as well as areas along the walls where internal lava slumping had occurred after the main flows had ceased but while the internal lava was still hot and plastic. We also observed layers of massive and vesicular basalt in the tube walls; these alternated with depth (massive units topped by vesicular units) since progressive accumulation of lava occurred in these layers before they had been subsequently incised and exposed by younger, higher temperature lava flows.

Our friendly and educational Savannah Guides gave us an overview of the geological and modern history of the tubes, and to our enjoyment used humorous analogies to help explain the intricacies of the tubes to those of us that were less volcanologically inclined, for example: likening the structure of the tubes to a "Freddo Frog once the caramel has been sucked out"; comparing the lava levels on the walls to "dry soup marks in a bowl"; and likening the upward transition from massive to vesicular basalt in the walls to "a beer mate, frothy on top and more smooth in the middle". There were also sightings of small insectivorous bats, bush turkeys and other birds, and a brown snake which livened up proceedings as we wandered back to the vehicles for our departure.

After leaving the Lava Tubes mid-afternoon and driving until the sunset was reflected in the rear-view mirrors, we stopped again at Ravenshoe for coffee and cake before heading back down to the coastal plain and into Cairns at dusk. All in all, we had a long but highly enjoyable and informative day and were able to see some very interesting features of the inland landscape, particularly those associated with some of the Late Quaternary volcanic activity of Undara in north Queensland. The Gulf Savannah country, with its pockets of dry rainforest, was a striking contrast to the drier woodlands on the far western slopes of the Atherton Tablelands, making the experience a great one overall. Our sincere thanks go to Peter Whitehead and to the other organisers and helpers involved with the Undara Lava Tubes field trip, as well as to the XVII INQUA congress committee for all of their efforts before and during the conference.

For some accessible information on the Undara Lava Tubes, see: The Environmental Protection Agency/Queensland Parks and Wildlife Service website (www.epa.qld.gov.au/projects/park/index.cgi?noback=1&parkid=133), the Undara Experience website (www.undara.com.au), and a recent Undara Lava Tubes article reproduced from Geo Australasia (www.undara.com.au/geo).

Finally, in recalling the Undara field trip and the XVII INQUA conference in Cairns, 28 July – 3 August 2007, we also remember the enjoyable days shared with Geoff Humphreys, both at his last convention and at many other times over the years. Geoff was a great colleague, mentor and friend to many of us, and will be sorely missed, although his legacy will carry on through his important contributions to pedology and geomorphology, and also through his colleagues and students.

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Photo 1 – The distinctive savannah and "dry rainforest" vegetation around the Lava Tubes (recently burnt).

Photo 2 – A collapsed section of tube with basalt rubble and intrusive "dry rainforest" vegetation.

Photo 3 – The mouth of a tube near a bifurcation point looking back to a collapsed section with rubble and "dry rainforest".

Photo 4 – Rubble in the mouth of a tube and silcrete infill giving the false impression of a dipping tube floor (actually, the lava flow direction was away from the position of photographer and towards the mouth which is in view).

Photo 5 – The internal ceiling of a tube which was slightly weathered and displayed a rough-textured cooling surface with an array of colourful patterns.

Photo 6 – The internal walls of a tube with visible lava flow levels, some cave coral and a silcrete floor that had partly infilled the cave.

Photos: T. Ralph and K. Tomkins.

The Low Isles

A near perfect day, and a warning from paradise

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I first caught site of the Great Barrier Reef as my flight banked and looped over the sea on its final approaches to Cairns. Dotting the ocean's abyssal blue were lighter patches of aqua and pale yellow, with darker points of green signifying the presence of those idealised tropical islands fixed in my imagination. Coming from the wintry climes of New Zealand, I welcomed with relish the idea of swimming in those warm tropical waters. While having spent time in the tropics before, this would be my first opportunity to visit a tropical reef and savour its beauty in person.

I ensconced myself at the bow of the good ship *Wavedancer*, a robust but sleek catamaran, and she powered us gracefully away from Port Douglas and out towards the Coral Sea. We were destined for two dark points low on the horizon, thirteen kilometres away: the Low Isles. The Sun blazed from a near cloudless sky onto a glittering sea, the water sparkling with countless scintillations sharp enough to still see them after looking away. The morning breeze was mild and warm. Turning to gaze landward, I saw the Queensland coast expand to the north and south, the vertiginous ramparts of the Great Escarpment dominating the sky line. Turning once more into the breeze, I basked in the heat and watched the dark points ahead turn gradually into islands.

The Low Isles are the most southerly-of forty-six coral platforms unique to the inner shelf on this part of the Great Barrier Reef. Long known to the Aboriginal people in this area, they were sighted by Captain James Cook on Trinity Sunday, 10 June 1770 (Fairbridge and Teichert, 1948). One of the isles is a small vegetated sand cay with a lighthouse station that was completed in 1878 and eventually demanned in 1993. The other isle is essentially mangrove, most of which is permanently awash but appears as an island from afar. The Low Isles are the most intensively studied low wooded coral reef islands on the Great Barrier Reef. The mangrove isle has extended greatly throughout the 20th century (Stoddart et al., 1978). Unlike the outer reef, the Low Isles have been strongly influenced in their development by river flood plumes emanating from the coast, and the inter-reef sediments are dominated by terrigenous mud (Frank and Jell, 2006). Like many other reefs the isles take on an arcuate horseshoe form, shaped by prevailing winds as the coral eventually reaches the sea surface (Scoffin et al., 1978). Geographical surveys over the last century have shown that considerable changes on Low Isles Reef are related to remobilisation of coarse sediment during storm events, which change the island's topography and substantially alter the size and location of shingle ramparts which affect conditions for coral growth on the reef flats (Cheal et al., 2002; Fairbridge and Teichert, 1948). On 11 February 1999 severe tropical cyclone Rona tore across the area to the east and north of the Low Isles, reducing their hard coral cover from 24% to 8%. A year later the coral cover had recovered to 13%. Recent observations also suggest gradual shoreline retreat associated with rising sea level (Frank and Jell, 2006).

Wavedancer dropped anchor, and after being ferried by glass-bottom boat to shore, the moment I had been eagerly awaiting was upon me. I donned my mask, snorkel and flippers, and after a moment refamiliarising myself with the wonderful sensation of breathing underwater, sedately set off to explore. There are 400 species of coral on the reef, including mushroom, plate, brain and staghorn corals. To my untrained eye the reef was a dense garden of otherworldly shapes, intricate convolutions and swirls, delicate feather-like fronds, transfixing iridescence. Floating on the surface I watched myriad species of colourful fish, schools of small ones flitting amongst the corals, larger solitary ones patrolling more slowly, beaked parrot fish gnawing the coral surfaces. Giant clams dotted the bottom. I swam a bit further, and all of a sudden a sea turtle was gliding serenely below me. I dived and came alongside, and my fascinated stare was returned with one of indifference. The creature tolerated my presence for a few more flipper strokes then, as if to highlight my submarine inadequacy, powered away effortlessly. Subsequently, I saw turtles that had wedged themselves into the coral on the bottom. I at first thought they were dead or sick and felt a pang of concern, but soon realised they were simply taking time out from their otherwise relaxed schedules.

Lunch was served aboard *Wavedancer*. We were treated to sumptuous fare, and I gorged on a small mountain of prawns and seafood salad. The only thing missing was chilled sauvignon blanc. Back on the beach it was low tide, and much of the near-shore coral along with giant clams was exposed. In the still heat of the afternoon I slowly walked the shore where sand met coral platform, and studied what had previously been immersed. Water that had filled the pores of the beach at last high tide seeped steadily from the sand, forming miniature gullies and rills that nibbled at the shore. The quiet murmur of the sea was punctuated periodically by the loud plop of some creature expelling water in the hot sun. Rubbery phallic forms of sea cucumbers glinted darkly in the sparkling shallows. Occasionally I spotted an individual coral polyp with its delicate, feathery feeding apparatus extended into the baking air, which was snatched back to safety from my probing finger. As time for departure drew near, it was time for a final swim. I explored more of the reef, again losing myself in the calm surreality of my surroundings, entirely in the present moment, in meditative communion with the

undersea realm. It was with reluctance that I emerged from those waters to be ferried back to *Wavedancer*. I settled at the bow once more to watch the coast draw near, and the mainsail was unfurled to take advantage of a favourable wind back to port. A colleague handed me a cool beer and, with easy-listening tunes crooned by a crewman with his guitar as mellow background, I relaxed in the late afternoon sun. And I realised that, for the first time in a very long time, I hadn't thought once that day about my PhD thesis. The day had been near perfect. As we neared the North Queensland coast, the firing of a sugarcane field was sending a large plume of black smoke into the bright azure sky.

The experiences and emotions of that day are made especially poignant considering the fragility and seemingly inevitable loss of places like the Low Isles. Throughout the last Termination and Holocene the reefs have contended with fluctuating sea levels and temperatures, and have for millennia been influenced by human activity (Pandolfi, 2007). Shifting patterns of phytoplankton population structure in the waters around the Low Isles are attributed to anthropogenic eutrophication caused by runoff from agricultural development (Bell and Elmetri, 1995). The remote nature of the Low Isles suggests such effects are widespread, and pose both direct and indirect threats to the corals from algal overgrowth and invasive species. Rising temperatures and increasing ocean acidity will further stress these delicate ecosystems, and the inexorable rise of the seas will eventually submerge and obliterate the idyllic picture postcard scenes of low wooded islands here and elsewhere. My thoughts turn to the Carteret and Mortlock Islands in Papua New Guinea, which are due to be abandoned by their human inhabitants as the ever-rising tides strip away shores and poison the soils, and which are becoming more vulnerable to the frightening inundations of storm surges. And Kiribati, where two uninhabited islands disappeared in 1999, and where the populated ones will soon too have to be left to the sea. And Tuvalu, the population of which New Zealand has agreed to accept over the coming years as environmental refugees, as these islands too sink beneath the waves (Pearce, 2006). The delicate reefs and their islands are serving as one of the many canaries in the coal mine of the Earth, which are already falling silent in an urgent warning to those who should pay heed.

I hope to make more trips to these stunning ecosystems. I fully expect to be as enthralled as this first time, simply grateful for such evolved beauty and complexity. But I am also aware that they are living through the time of the great anthropogenic extinctions that perhaps observers in the far future will read in the rocks. In the mean time I will savour their presence, and add them to my long list of things I hope will survive the Anthropocene, including us.

Acknowledgements

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Clockwise From Top Left: Main Lowe Isle, with Great Escarpment coastline in the distance; *Wavedancer*, with mangrove-wooded Low Isle in background; Shoreline at low tide; Near-shore corals in the shallows. Photos: Carol Smith

INQUA post-conference field trip to PNG

Climatic change, human impact and catastrophic events during the last 20,000 years in Papua New Guinea

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From the 4th to the 12th August 2007, 12 participants from Japan, USA, UK and Australia joined trip leaders Geoff Hope and Simon Haberle on an expedition through Papua New Guinea (PNG) (Photo A).

On Day 1 we assembled in Port Moresby, toured the city and gardens and flew on to Mt Hagen (1677 m, Western Highlands Province).

The following day we toured the surrounding region. We first stopped to look at the Tomba Tephra, one of a series deposited by the Mt Hagen volcano pre-50 ka (Pain and Blong, 1979). We passed through several villages, met some of the locals (Photo B), and stopped to view *Nothofagus*, *Cyathia Elaeocarpus* and *Weinmannia*. Hope Sensei (as he was soon to be called) also demonstrated the use of tanket (*Cordyline* sp., or "arse grass") for traditional dress (Photo C). With the help of Keith Bennett, a keen birder, we caught a glimpse of our first Bird of Paradise. After taking in spectacular views of the Tambul Valley we drove to see Mt Ambra and North Wahgi and Kuk Swamps, the latter of which has recorded human occupation and swamp modification since at least ~7ka (Denham et al., 2003).

On Day 3 we departed Mt Hagen and drove east towards Mt Wilhelm, the highest peak in PNG at 4509 m. We first travelled up the Wahgi River Valley along the Highlands Hwy then into Simbu Province. We stopped in the province capital of Kundiawa for lunch, then snaked our way 50 km up the spectacular Chimbu River Valley (Photo D) to overnight at Betty's Place, a famous lodge for would-be climbers of Mt Wilhelm. It was an arduous 3 hour drive over rickety bridges, bedrock outcrops and potholes. We caught glimpses through the fog and rain of vegetable gardens hanging off the side of cleared 35° slopes and saw the first of many large domestic pigs. Betty supplemented our simple dinner supplies with locally farmed trout and fresh vegetables.

The following day we headed out for base camp with the help of local bilum-carrying porters and guides (Photo E). They led us through *Pandanus* swamp forests, upper montane rainforest and the forest-grassland transition, before making our final ascent for the day though a spectacular valley of *Cyathea atrox* treeferns (Photo F), emerging at lower Lake Pindaunde (3480 m) (Photo G) and our overnight hut (the old ANU field station). Here we spent the day acclimatising to the altitude with a swim in the lake and a delicious lunch of corned beef and processed cheese sandwiches!

At 4am five adventurers departed for the six hour climb to the summit: two were successful and several more nearly so. Unfortunately the infamous cloudy conditions were less than ideal for views to the coast but Sumiko Kubo took pictures of Brass Tarn and the summit cairn in the mist (Photo H). After the return and (partial!) recovery of the summit walkers we descended to Betty's Place for the evening where a traditional *singsing* (Photo I) and *mumu* (ground oven) were presented. Dinner included some very fresh pork, root vegetables and locally grown strawberries.

The following day we drove back down the Chimbu Valley, sampling "dough balls" and alpine strawberries as we went, then on over the Daulo Pass (2478 m) and to Goroka, the capital city of the Eastern Highlands Province. This city is home to 25 000 inhabitants, including the famous Asaro Mudmen. The next morning, after visiting the McCarthy Museum, we flew on to Popondetta (Oro Province), via Port Moresby, a region best known for the WWII Kokoda Track. As is typical of most PNG travel experiences we were left waiting at the airport shed for several hours and played "hackey-sack" with some of the bemused locals to pass the time. When the hotel bus did arrive it broke down and we split up into passing 4WD's and people moving vehicles (buses, or PMV's) for a staggered arrival at the Lamington Hotel.

Our last evening as a group was celebrated with beers and pizza, with the "Lamington Volcano" voted the best. The following morning two participants (Iona Flett and Rachel Nanson) departed on what was supposed to be a 4 hour, 80 km dinghy ride across Dyke Ackland Bay and around Cape Nelson to the Tufi Dive Resort in the "Fjordlands of PNG". About 13 hours later, including a long wait for a bus, an even longer boat trip, a four hour night-hike and an outrigger river crossing, we arrived at the resort! The region is composed of steep rainforest and grassland-covered peninsulas formed of Pleistocene basaltic and andesitic flows and unconsolidated pyroclastics. These peninsulas radiate from the Mt Trafalgar complex of volcanoes (Photos J and K). Fluvial incision, subsidence and Holocene sea level rise have formed spectacular rias (colloquially referred to as fjords) between the peninsulas. The fjords are <600 m across (and up to 350 m deep, according to the locals!) and are fringed by coral and mangrove swamps which extend to their landward limits. The marine life is diverse and the region is famous for its huge variety of nudibranchs, sharks such as the White Hammerhead and its colourful assortment of corals and sponges.

Figure 1 (left). A: Members of the group inspecting the Tomba Tephra, Western Highlands Province; B: The first of many locals to spontaneously appear beside us as we stopped to look at roadside features; C: Geoff Hope modelling a few choice tufts of *tanket;* D: A view up the Chimbu River Valley; E: Our porters for the Mt Wilhelm walk, who chose to carry our state-of-the-art backpacks in more comfortable bilums strung around their foreheads, are seen here crossing a small bridge; F: We walked through this spectacular valley of *Cyathea atrox* (treeferns) on our hike up Mt Wilhelm.

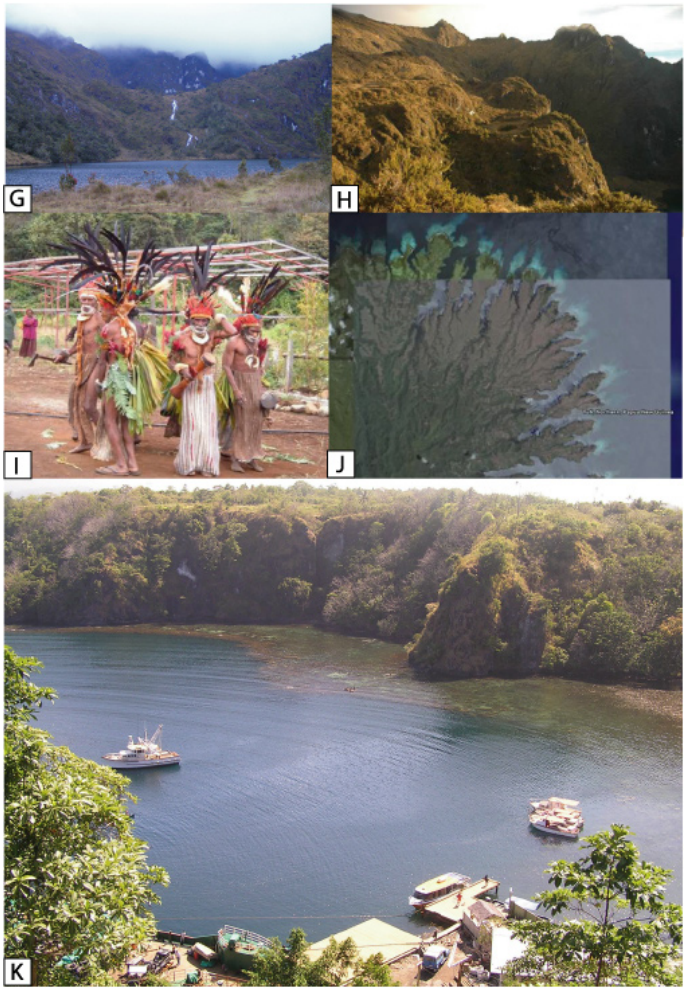

Figure 2 (below). G: Lower Lake Pindaunde on Mt Wilhelm, next to the ANU hut, where a few participants took a refreshing swim while acclimatising to the altitude (3480 m); H: Brass Tarn, Mt Wilhelm; I: Men performing a traditional *singsing* to accompany our *mumu* (ground oven) dinner feast at Betty's Place; J: A Google Earth view of the rias of the Cape Nelson, known as the fjordlands of PNG (Oro Province). Tufi Dive Resort (Photo K) is marked in the lower right; K: A small alcove of a coral fringed fjord, viewed from the Tufu Dive Resort.

Meanwhile the remainder of the group viewed Mt Lamington (1680 m) near Popondetta. Thought to be an extinct stratovolcano, it violently returned to activity with a devastating Pelean type eruption in 1951. The event caused pyroclastic flows, deposited 0.15-0.6 m of ash across an 8 km radius (Taylor, 1957) and killed over 3000 people. Despite the destruction of most vegetation in this zone, local crops recolonised within months and forests within several years (Taylor, 1957).

The final day of the official fieldtrip saw the departure of most of the attendees on a flight back to Port Moresby. However, despite careful planning (and valid tickets!) the flight was overbooked and several passengers had to wait until the following day to catch the next flight to Port Moresby.

Despite the trials of PNG travel and the infamous potential for misadventures with *raskols*, the trip was a great success and we were treated to excellent Papua New Guinean hospitality. In a little over a week the trip leaders exposed the participants to some of the most remote, spectacular and little known geomorphic, cultural and culinary highlights of the country.

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The Sir Nicholas Shackleton Medal for outstanding young Quaternary scientists

Sir Nicholas Shackleton was a towering figure in the field of Quaternary science and, to honour his pioneering career in geochronology and paleoclimatology, INQUA has established The Shackleton Medal. It will be awarded once every four years to an outstanding young (35 years or younger) Quaternary scientist, chosen by his or her peers and evaluated by a blue-ribbon committee of distinguished scientists.

At the XXVII INQUA Congress in Cairns the medal was awarded to Dr Chris Turney: "...for his pioneering research breakthroughs across a range of Quaternary topics, and among them paleoclimatology and geochronology, publishing a prodigious number of high quality scientific publications, and for being inordinately active in promoting Quaternary science to a wide international audience." (from the medal citation).

There can be no doubt that the blue-ribbon committee got this one right. In little over 10 years as a researcher, Chris has been involved in high profile investigations ranging across Quaternary science, including isotopes, C^{14} dating, Icelandic tephra, Irish oaks, New Zealand kauri, Queensland peat, ENSO, Australian extinctions, glacial terminations, fire, and not forgetting the discovery of the extraordinary Homo floresiensis. He has published more than 60 refereed papers (including two in Nature), numerous abstracts and reports, three books, and been a lead investigator on over 30 grants. This activity has not come at the expense of wider engagement. Chris has thrown himself wholeheartedly into learning the craft of speaking to and writing for the general public. He has written a successful popular science book (Bones, Rocks and Stars: The Science of When Things Happened 2006) which is currently been

translated into Spanish, Chinese and Finnish, and has another forthcoming (Ice, Mud & Blood: Lessons from Climates Past, Palgrave Macmillan). Besides the books, he has numerous articles in the press (including the New Scientist, The Times (UK), The Sunday Times (UK), The Bulletin (Australia), plus appearances on radio and TV. At 34 years of age, he has achieved more than many do in their entire careers.

Chris has successively held posts at NZ Landcare Research, ANU, Royal Holloway, Queen's University, University of Wollongong and now has accepted the post of Chair in Physical Geography, University of Exeter and a well deserved professorship. A consummate networker he has been generous in sharing his, knowledge, resources, enthusiasm and good humour with his colleagues and students. Australasia has been Chris's second home, and we are proud that one we consider our own has won this prestigious award. Well done, Chris, good luck in your new post, and don't leave it too long before our corridors ring again with your ear-shattering laugh!

Matt McGlone

Landcare Research, Lincoln, New Zealand.

Report

Trends in the ARC 2002-2007

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Below is an outline of the successful grants in the latest ARC Discovery, Linkage and LIEF round (funded for 2008-2012). Congratulations to all those who were successful. These included one APF, six ARF/QEII fellowships, seven APD's, and three APDI's, which is an excellent result for early career researchers. The successful grants included twenty-four Discovery, five Linkage and four LIEF grants. As in previous years I've compared the results of this year's round with the previous five years and there are some interesting trends and encouraging signs of continued ARC support for Quaternary research. Just to note that my interpretation of what constitutes Quaternary research projects is fairly broad and incorporates all archaeology-related projects as well (though these are distinguished in the analysis).

In general the trends in Discovery grant funding can be summarised as follows (Fig. 1):

(i) total number of grants and funding continues to increase (~ 3-fold) in a stepwise fashion since 2002
(ii) funding of around $11.2 million for Discovery grants in Quaternary research was achieved this year and is the highest awarded so far
(iii) components of archaeology continue to feature strongly in over 50% of Quaternary research applications

(iv) of the 14 successful archaeology grants only 1 could be considered as Australian field-based research (similar to previous years)
(v) the number of institutions administering grants remains relatively stable at 12 (similar to previous years)
(vi) the gender balance continues to be weighted towards male principle CI's, though this year the most successful grantees, receiving 3 grants each (including Linkage and LIEF), are female.
(vii) Australia's megafauna (faunal extinctions) seems to be the most popular recent topic with 8 projects (~$3mil) dealing with this issue over the last 2 years.

Overall, this is a very positive result for Quaternary research in Australia, reflecting a vibrant and increasingly relevant area of research. Certainly, these projects are increasingly capturing the attention of the current ARC board of assessors with a significant rise in percentage of total grants awarded from 1% in 2002 to ~3% in 2006-2007. The infrastructure to enable this trend to continue has also received a boost this year with grants for equipment and most significantly new funding provided for Australia's re-entry into the Ocean Drilling Program assured for the next 5 years. This last factor, along with the network funding available (but perhaps not widely accessed as yet) from the three most relevant ARC Networks (Environmental Futures Network, Earth System Science Network and the Network for Vegetation Function) all provide a framework for exploring new ideas and collaborations across the broad palette of Quaternary research. For those applicants who missed out this year this must provide incentive to try and try again.

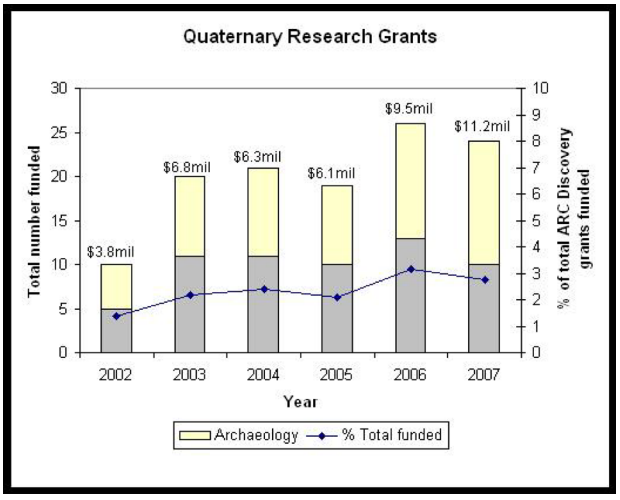

Figure 1. Quaternary Research ARC Discovery Grants announced in 2002-2007. The bar graphs show total number of Quaternary Research grants funded, the line shows % this represents of total number of grants allocated in that year, and a figure for the total funding in million dollars allocated to Quaternary Research projects appears above each year. Data from the ARC annual reports 2002-2007 (http://www.arc.gov.au/ncgp/dp/dp_outcomes.htm).

Successful ARC grants announced in 2007 for 2008-2012

DISCOVERY GRANTS

ARCHAEOLOGY AND PREHISTORY / ANTHROPOLOGY

CI's: Dr DK Curnoe; Prof PS Tacon; Dr SD Mooney; Dr DA Penny; Mr J Xueping; Dr R Pan; Dr D Fink; Dr AI Herries (ARF)
The Late Pleistocene Peopling of East Asia and Associated Climate Environment History
The University of New South Wales: 2008, $150,000; 2009, $140,000; 2010, $140,000; 2011, $130,000; 2012, $105,000

CI's: A/Prof AV Betts; Prof VN Yagodin; Dr FJ Kidd (APD)
A study of a newly discovered corpus of early Central Asian wall paintings
The University of Sydney: 2008, $140,000; 2009, $130,000; 2010, $130,000; 2011, $125,000

CI: Dr MJ Carter (APD)
With or without pots: Investigating the archaeology of human settlement on Santa Isabel, western Solomon Islands.
The University of Sydney: 2008, $85,000; 2009, $80,000; 2010, $60,000; 2011, $58,986

CI: Mr DH Evans (APD)
Hydraulic Systems and State Development in Early Cambodia: Mapping the Engineered Landscapes of the Khmer Using Remote Sensing.
The University of Sydney: 2008, $95,000; 2009, $90,000; 2010, $80,000

CI: Mr AR Brumm (APD)
A reassessment of early human stone technology from a Southeast Asian perspective.
University of Wollongong: 2008, $100,000; 2009, $95,000; 2010, $85,000

CI: Dr D Frankel; Dr JM Webb
Diversity, interaction and change in prehistory: the third millennium BCE in Cyprus.
La Trobe University: 2008, $152,000; 2009, $130,000; 2010, $130,000; 2011, $70,000

CI's: Dr B David (QEII); Prof J Geneste; Dr KM Marsaglia; Dr H Plisson
Archaeology of the Gulf Province Lowlands, Papua New Guinea.
Monash University: 2008, $180,000; 2009, $175,000; 2010, $170,000; 2011, $130,000; 2012, $90,000

CI's: Dr SH Bedford (QEII); Prof MJ Spriggs
Persistence and transformation in Ancestral Oceanic Society: the archaeology of the first 1500 years in the Vanuatu archipelago.
The Australian National University: 2008, $275,356; 2009, $249,821; 2010, $273,532; 2011, $244,847; 2012, $285,189

CI: Dr JA Cameron (ARF)
Indian Textile Technology as archaeological evidence for population movements in Early Southeast Asia.
The Australian National University: 2008, $110,000; 2009, $124,000; 2010, $120,000; 2011, $105,000; 2012, $98,643

CI's: Dr SL O'Connor; Dr AR McWilliam
Cultural and Environmental Shifts in Late Holocene East Timor: Evidence for Climate Change?
The Australian National University: 2008, $143,000; 2009, $140,000; 2010, $97,000

CI's: Dr SL O'Connor; Dr SJ Fallon
Impacts of Catastrophic Marine Inundation Events (CMIEs) on the Prehistoric Archaeological Record of the Australian Coastline.
The Australian National University: 2008, $130,000; 2009, $125,000; 2010, $120,000

CI's: Dr MJ Prebble; Dr NA Porch
Using fossil insects and plants to recognise past human impacts on Pacific island biodiversity.
The Australian National University: 2008, $60,751; 2009, $68,431

CURATORIAL STUDIES

CI's: A/Prof RJ Sloggett; A/Prof AG Sagona; Ms D Lau
Archaeological conservation: the development of analysis and assessment protocols for adhesives used on archaeological pottery
The University of Melbourne: 2008, $40,737; 2009, $38,398; 2010, $38,398

CULTURAL STUDIES

CI's: Prof PS Tacon; Dr J Ross; Dr AG Paterson; Dr SK May (APD)
Picturing change: 21st Century perspectives on recent Australian rock art, especially that from the European contact period.
Griffith University: 2008, $155,000; 2009, $150,000; 2010, $150,000; 2011, $110,000

GEOLOGY/ GEOCHEMISTRY

CI's: Dr LJ Arnold (APD); Dr RD MacPhee; Dr H Poinar
Pleistocene evolutionary dynamics and past environments of Siberia: Reconstructions using luminescence dating of ancient DNA sedimentary archives.
University of Wollongong: 2008, $115,000; 2009, $114,000; 2010, $109,000

CI's: Prof RG Roberts (APF); Prof AR Chivas; Dr MD Petraglia
Monsoons and migrations: Quaternary climates, landscapes and human prehistory of the Arabian peninsula and the Indian subcontinent.
University of Wollongong: 2008, $155,000; 2009, $130,000; 2010, $125,000; 2011, $110,000; 2012, $100,000

CI's: Prof K Grice (QEII); Prof RE Summons; Dr RJ Twitchett
Characteristics of organic matter formed in toxic, sulfide rich modern and ancient environments.
Curtin University of Technology: 2008, $140,000; 2009, $190,000; 2010, $170,000; 2011, $85,000; 2012, $75,000

CI's: Prof MA Williams; Dr MR Talbot; Dr JC Woodward; Prof GA Duller; Prof MG Macklin
Environmental impacts of climate change in the Nile basin over the past 30,000 years.
The University of Adelaide: 2008, $90,000; 2009, $80,000; 2010, $80,000

ECOLOGY AND EVOLUTION

CI's: Dr PJ Baker; Dr ER Cook; Dr JM Lough
Reconstructing the historical frequency and intensity of Australian droughts: A multi species dendrochronological approach.
Monash University: 2008, $170,000; 2009, $148,000; 2010, $145,500

CI: Dr AR Evans (ARF)
Megafauna and mega extinction: assessing palaeocommunity change using dental complexity and shape analyses.
Monash University: 2008, $200,000; 2009, $100,000; 2010, $100,000; 2011, $100,000; 2012, $100,000

CI: Dr GJ Price (APD)
Constructing a temporally constrained palaeoecological model of Quaternary faunal evolution and extinction in eastern Australia.
The University of Queensland: 2008, $100,000; 2009, $100,000; 2010, $100,000

CI's: Prof BW Brook; Prof CN Johnson
Reconstructing past population dynamics to understand human and climatic impacts in prehistory.
The University of Adelaide: 2008, $213,000; 2009, $213,000; 2010, $198,000

OCEANOGRAPHY

CI's: Dr SM Eggins; Dr BN Opdyke; Prof J Zachos; Dr A Russell
Atmospheric CO_2, global temperature, and surface ocean acidity response to fossil carbon burning: insights from an ancient analogue.
The Australian National University: 2008, $90,000; 2009, $114,000; 2010, $109,000

LINKAGE GRANTS

ARCHAEOLOGY AND PREHISTORY / ANTHROPOLOGY

CI's: Prof TA Murray; Dr PW Davies (APDI)
An Archaeology of Institutional Confinement: the Hyde Park Barracks 1848-1886.
La Trobe University: 2008, $78,648; 2009, $78,648; 2010, $78,648
Collaborating/Partner Organisation(s): Historic Houses Trust of NSW

CI: Dr SL O'Connor
Bayini, Macassans, Balanda and Bininij: A Case Study of Indigenous Cultural Heritage Management and Tourism in West Arnhemland Northern Territory.
The Australian National University: 2008, $77,800; 2009, $72,200; 2010, $80,000
APA(I) Award(s): 1
Collaborating/Partner Organisation(s): Department of the Environment and Water Resources; Bushfires Northern Territory.

CI's: Prof GJ Hugo; Dr B Craig
The development and testing of a theory of the processes that shape material culture diversity using a New Guinea dataset
The University of Adelaide: 2008, $70,000; 2009, $60,000
Collaborating/Partner Organisation(s): OK Tedi Mining Limited, South Australian Museum

ANALYTICAL CHEMISTRY

CI's: Dr CE Lenehan; Dr JS Quinton; Dr P Jones; Prof A Pring; Mr A Durham
Chemical Fingerprinting for Geological and Geographical Provenancing of Ochre Minerals used by Australian Aboriginals.
The Flinders University of South Australia: 2008, $50,000; 2009, $50,000; 2010, $50,000
Collaborating/Partner Organisation(s): South Australian Museum, Artlab Australia.

GEOCHEMISTRY

CI's: Dr RT Bush; Dr P Slavich; Dr SG Johnston (APDI); Prof LA Sullivan; Dr ED Burton
Impacts of climate change on coastal floodplain wetland biogeochemistry and surface water quality.
Southern Cross University: 2008, $80,000; 2009, $84,000; 2010, $82,000
Collaborating/Partner Organisation(s): NSW DPI, Richmond River County Council, Northern Rivers Catchment Management Authority

LARGE INFRASTRUCTURE AND EQUIPMENT FUND

GEOLOGY

CI's: Prof RJ Arculus; Prof P De Deckker; Dr NF Exon; Prof ME Barley; Dr JJ Brocks; Dr MB Clennell; Prof A Cooper; Prof JR Dodson; Dr RN Drysdale; A/Prof CL Fergusson; A/Prof JM Hergt; Dr WR Howard; Prof AP Kershaw; Prof TC McCuaig; A/Prof RD Muller; Dr IR Poiner; Prof SY O'Reilly; Dr JM Webster; Dr CJ Yeats; A/Prof PM Vasconcelos; Dr JD Stilwell
Australian Membership of the Integrated Ocean Drilling Program.
The Australian National University: 2008, $1,200,000; 2009, $1,200,000; 2010, $1,200,000; 2011, $1,200,000; 2012, $1,200,000
Partner Organisations & Collaborating Organisations: The Australian National University, CSIRO, MARGO, Macquarie University, James Cook University, The University of Adelaide, The University of Melbourne, Monash University, The University of Newcastle, The University of Queensland, The University of Sydney, University of Tasmania, The University of Western Australia, University of Wollongong, AIMS, ANSTO

GEOCHEMISTRY

CI's: Prof K Grice; Dr PF Grierson; Dr PF Greenwood; Dr JJ Brocks; Prof D Zhang; A/Prof A Heitz
A novel isotope facility to characterise high molecular weight fractions of natural organic matter in soils, sediments, water, petroleum and coal.
Curtin University of Technology: 2008, $160,000
Partner Organisations & Collaborating Organisations: Curtin University of Technology, The University of Western Australia, The Australian National University, CRC WQT, John de Laeter State Centre of Mass Spectrometry

CI's: Prof AR Chivas; Prof RG Roberts; Dr Z Jacobs; Prof CV Murray Wallace; Dr KE Westaway; Prof MJ Morwood; Prof GC Nanson; A/Prof BG Jones; Dr PF Carr; Dr HV McGregor; Prof CD Woodroffe; A/Prof SD Golding; A/Prof J Zhao; Dr K Yu; Dr JM Pandolfi; Dr GP Halverson; Prof MA Williams; Dr PA Gell; Dr DJ Chittleborough; Prof JR Dodson; Dr D Fink; Dr Q Hua; Dr EJ Hodge; Dr TM Esat; Prof MT McCulloch
A stable isotope mass spectrometer for novel determinations of past temperatures.
University of Wollongong: 2008, $250,000
Partner Organisations & Collaborating Organisations: University of Wollongong, The University of Queensland, The University of Adelaide, Australian Nuclear Science & Technology Organisation, The Australian National University

PHYSICAL CHEMISTRY (INCL. STRUCTURAL

CI's: Prof PA Lay; Prof D McNaughton; Prof Dr T Maschmeyer; Prof DT Potts; Prof MV Swain; Prof GE Grau; Prof TC Sorrell; Dr IM Ramzan; Prof J Beardall; Prof CC Bernard; Dr CP Marshall; Dr A Dutkiewicz; Dr DA Penny; Dr BR Wood; Dr W Yang; Dr L Soon; Dr D Traini; Dr EA Carter
Integrated Vibrational Spectroscopic Mapping for Archeological, Biological, Geological, Materials, and Medical Research.
The University of Sydney: 2008, $ 400,000
Partner Organisations & Collaborating Organisations: The University of Sydney, Monash University

LINKAGE INTERNATIONAL AWARDS

GEOCHEMISTRY

CI's: Prof K Grice; Prof P Ward
Chemostat experiments to mimic toxic environments associated with mass extinction events.
Curtin University of Technology: 2008, $10,000; 2009, $ 8,450
Collaborating Countries: USA

Eastern Mediterranean, Black Sea and Caspian Biomes Workshop (IGCP-521 Group 2), 11-14 April 2007, Brunel University, Uxbridge, United Kingdom

Simon Connor

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The shores of the Eastern Mediterranean, Black and Caspian Seas have been home to farming and pastoral communities for most of the last 10,000 years. Ever since the emergence of agriculture in this region, its economies, landscapes and ecosystems have been strongly influenced by past sea level changes. IGCP project 521 (*The Black Sea-Mediterranean Corridor during the last 30 ky: sea level change and human adaptation*) aims to bring together scientists from many different disciplines to produce a more complete picture of how past sea level changes impacted upon coastlines, vegetation, settlement patterns and subsistence, an understanding of which can help us to anticipate the socio-economic effects of predicted global sea-level rise.

With this grandiose aim in mind, the project's palynology working group met in April for a four-day workshop to begin the not-inconsiderable task of analysing data from over 70 years of palynological research in the 25 or so countries in the study area. The meeting took place at Brunel University in west London and was led by Sandy Harrison (Bristol) and Carlos Cordova (Oklahoma State) and hosted by the ever-hospitable Susanne Leroy (Brunel). Others in attendance were Petra Mudie (Geol. Survey Canada), Natalie Ortiz, Ana Garcia-Suarez (Bristol) and Yours Truly. Several other scientists contributed data even though they were unable to attend the meeting in person.

From the outset, the goal of the meeting was to churn the project's pollen database through a 'biomisation' procedure to come up with maps of reconstructed vegetation for the last 30,000 years. Biomisation is an objective method for vegetation reconstruction developed in the mid-1990s by Prentice and co-workers (see *Climate Dynamics* 12: 185-94). Unlike methods based on indicator species, biomisation assigns pollen types to plant functional types (PFTs) and then uses ecological knowledge to assign groups of PFTs to biomes. The method has been applied with success in many parts of the globe, including a handful of sites from the Eastern Mediterranean, Black and Caspian Seas region.

Almost immediately, it became clear that our collective hope of leaving the meeting with a set of palaeovegetation maps was perhaps overly ambitious. The database required major work to rectify omissions, duplications, pollen taxonomy issues, inadequate site descriptions and other niggling problems. A number of these issues were inherited from the global databases from which some data were obtained. Fixing them was perhaps the workshop's single most significant achievement, after which focus turned to the question of the biomes present in the study area and how to define them in terms of PFTs. This initiated a robust debate on vegetation classification and the "detectability" of certain vegetation formations in pollen data. The working group came up with 19 categories for the region's vegetation, ranging from the alpine meadows of the Caucasus Mountains, through the humid liana forests of the Black Sea coast, the sclerophyll scrub of the Mediterranean, the grassy steppes of the Ukraine and southern Russia, to the desert vegetation of the Arabian Peninsula and Central Asia.

The workshop concluded with a number of future directions and tasks. More data are being incorporated into the database to extend its spatial and temporal scope. The region's current vegetation is now being compared with climatic data to enclose each of our 19 "biomes" in a bioclimatic envelope. In the near future, pollen taxa will be assigned to PFTs and this will enable the biomisation procedure to be run on surface samples to see how the results accord with observed vegetation. Once these tasks are completed, the results are to be published and the biomisation of fossil pollen data can proceed. The outcome will be the first detailed, objective reconstruction of the region's vegetation history, illuminating the large-scale effects of changing climates and sea levels, and revealing the environments in which great civilisations and diverse cultures flourished, here at the very crossroads of Europe, Africa and Asia.

Many thanks to the Australasian Quaternary Association for a student travel prize and the IGCP Committee for an Australian Government-sponsored grant-in-aid. For more information on this project, please see www.bridge.bris.ac.uk/projects/EMBSECBIO.

Leitfaden der Pollenbestimmung für Mitteleuropa und angrenzende Gebiete (A Guide to Pollen Identification for Central Europe and Surrounding Areas

This new guide to the identification of pollen from central Europe and surrounding areas presents a comprehensive pollen flora of exceptional standard. The work is the culmination of tremendous effort and longstanding dedication by the author over the past four decades. A thorough set of instructions accompanies the extensive, illustrated key to 30 pollen morphological classes (e.g. tetrad, monoporate, tricoporate), each of which is further explored in detail in its own chapter. In total, 586 pollen types are outlined with particular attention paid to types that are the most difficult to identify. Excellent light microscope photographs, most of which are presented at x1000 magnification, are spread over 120 photographic plates. Although written in German, Beug employed the widely accepted pollen morphological terminology of Faegri and Iversen (1989) which, together with the highly structured key and a list of pollen morphological terms, ensures that all palynologists should find the book easy to use. This pollen flora is especially valuable to Australian pollen labs for its use as a comprehensive and detailed guide to the identification of introduced taxa as well as many of the cosmopolitan aquatic species. It should also serve as a useful teaching aid, providing many and varied examples of pollen morphological classes. For Australian labs working on sites in the Eurasian region this reference work will be essential.

Reference

• Faegri, K. and Iversen, J. 1989. Textbook of Pollen Analysis. John Wiley and Sons, Chichester, 4th edition, 328 pp.

Reviewed by Sander van der Kaars and Ellyn Cook
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H.-J. Beug
Published by Verlag Friedrich Pfeil, München, Germany, 2004 (542 pages, 120 plates, 12 tables, hardback), €90.00
(www.pfeil-verlag.de)
ISBN 3-89937-043-0

Passing of Geoff Humphreys, 12th August 2007

Geoff Humphreys died suddenly and unexpectedly in Sydney recently. Geoff's interest in the formation of soil, and his breadth of experience and interests brought him into contact with many in the Quaternary, ecological and geomorphological communities. Geoff considered his most important work to be on the role of bioturbating fauna in soil formation but along the way he has also made important contributions to studies of soil erosion and land degradation, ecology, geomorphology as well as the Quaternary. In late July Geoff attended the INQUA Congress in Cairns and presented work on novel methods of dating and measuring soil formation rates over Quaternary time-scales. The many conversations he had with a wide range of colleagues at INQUA excited him with new enthusiasm for future projects exploring these themes.

Geoff was born in Sydney in 1953 but spent his early childhood on the north coast of NSW at Murwillumbah before his family returned to Sydney after his father's early death. Geoff enrolled at Macquarie University as an undergraduate in the early 1970s taking full advantage of the flexibility Macquarie offered by studying a mix of geography, geology and biology. This multi-disciplinary approach stayed with Geoff throughout his career as he devised new ways of understanding the role of the biosphere in soil formation. Geoff met his wife Janelle at Macquarie and together they moved to Papua New Guinea, first in Chimbu Province in the Highlands and later at the University of Papua New Guinea. Geoff worked on his PhD as a student of Macquarie University before and during his time in PNG, somehow managing to work up the Sydney-based field data while living in PNG, teaching at the University of Papua New Guinea and raising a family. After graduating in 1985, Geoff took up a position at the University of New South Wales in 1987 and then, in 1989, an appointment in the Land Management Project in the Research School of Pacific Studies at ANU which saw him return to PNG for long field seasons. Geoff began lecturing at Macquarie University in mid-1994 just as he and his Macquarie colleagues Ron Paton and Peter Mitchell were completing their book "Soils: A new global view". One of Geoff's proudest achievements was to be awarded (with his co-authors) in March 1999 the G.K. Gilbert Award for excellence in geomorphological research by the Geomorphology Specialty Group of the Association of American Geographers for this book and for the impact the book created. In the last 13 years Geoff has revelled in the supervision of many students in a range of subjects. Somewhere in each of those projects were a link back to understanding how soils form and an original and imaginative approach to tackling intractable problems.

As recently as the Friday before his sudden death, Geoff came into the field at Blayney and Newnes Plateau (Blue Mountains) to introduce sites to my group of INQUA conference fieldtrip participants and was having a great time being outdoors, digging holes, talking about his research and engaging with people interested in understanding how landscapes function. Having parted with a casual "see you on Monday" it was literally incredible that we didn't.

Geoff will be greatly missed by his many friends, colleagues, past and present, and former students as well as his family: Janelle, Sheridan, Lachlan, Rowan, William and grandson Max.

Paul Hesse
Department of Physical Geography
Macquarie University

Taking a stance against Acacia regrowth
(Photo: Kerrie Tomkins)

Colin George Vucetich BAgrSc
06.09.1918 – 25.04.2007

A pioneering New Zealand tephrochronologist and soil stratigrapher

Many Quaternarists, tephrochronologists, and soil scientists mourned the passing in New Zealand of Colin Vucetich – gentle mentor, pedologist, and pioneering tephrochronologist – on 25th April (Anzac Day), 2007. Colin was in his 89th year. As well as forming a 25-year partnership with W.A. 'Alan' Pullar, with whom he published three classic papers on tephrostratigraphy based on field work undertaken by the pair largely in their own time, Colin inspired and mentored numerous postgraduates in his later career as an academic at Victoria University of Wellington. There he taught pedology, soil stratigraphy, and tephrochronology until his retirement as Reader (Associate Professor) in 1982. In retirement he was an honorary lecturer and supervisor at Massey University (Palmerston North) until 1991. These graduates are grateful to him for setting them on their respective paths in soil science, geomorphology, geology, ecology and archaeology. They include Tonkin, Milne, Nelson, Williams, Kohn, Neall, Topping, Howarth, Plume (nee Roxburgh), Park, McIntosh, McFadgen, Wilde, Kaewyana, Nairn, Hull, Rogers, Froggatt, Palmer, Eden, McLeod, Purdie, Berryman, Stevens, and Trustrum at VUW, Alloway at Massey University, and Hodder, Hogg, and Lowe at Waikato University.

Colin was born on a south Canterbury farm and moved to Timaru, where he attended Waimataitai Primary school and Timaru Boys' High school. At Canterbury Agricultural College (now Lincoln University) he graduated Bachelor of Agricultural Science in 1940. He served in a medical corps of the 3rd New Zealand Army Division in the Pacific from 1942 to 1945 spending periods in Fiji, and on Vella Lavella in the Solomon Islands. Post war Colin Vucetich and Alan Pullar were employed by Soil Bureau DSIR where they learnt on the job, surveying soils of the downs and plains of Canterbury. Subsequently Colin and others began the reconnaissance soil survey of the South Island. Colin was transferred from Christchurch to Rotorua in 1951, and Alan Pullar from Timaru to Gisborne in 1948. In Rotorua, Colin's brief was to survey soils of forestry and farm development areas in the central North Island. This resulted in soil bulletins covering the northern part of the Kaingaroa plateau and the Galatea basin, and of the Waiotapu region.

Colin and Alan recognised the need for a better definition of the stratigraphy and distribution of volcaniclastic sediments and tephras in the central volcanic region and east to the Gisborne Plains, studies then regarded as the role of the Geological Survey. They were confident that this would lead to an improved understanding of soil development and distribution. Reassessing work begun by Dr Leslie Grange, Norman Taylor and Ian Baumgart, they produced in collaboration with Jim Healy of the Geological Survey, the seminal NZ Geological Survey Bulletin 73, published in 1964. This documented the tephra stratigraphy of the central North Island, with reference sections and isopach maps. The soil stratigraphy within the tephra columns was used to develop a preliminary definition of tephra formations. From this and subsequent studies, Colin and Alan showed that the soil-forming Mairoa, Tirau, Waihi and Gisborne volcanic ashes were distal composite tephra columns made of many thin additions of dominantly rhyolitic with lesser additions

A. Norman Taylor and Colin Vucetich selecting a high country soil on Porters Pass for the 1962 ISSS Commission IV and V Conference South Island tour. Photo: Eddie Cutler.

B. Colin Vucetich in characteristic pose explaining the layered soil profile of a Taupo sandy loam in Kaingaroa Forest on 23 February 1981, during a post-conference "Soils With Variable Charge" field trip in the central North Island. Photo: Jim Pollok

C. Colin's lunch, on the 2004 Wanganui Basin 'Friends of the Quaternary' field workshop. Photo: Brent Alloway

D. Colin and Margaret have the last say. Photo: Brent Alloway

of andesitic and (rarely) basaltic ashes. This composite nature was later confirmed by more detailed studies by Colin's students and others at Waikato University.

Colin felt that the closure of the Rotorua office in 1958 was a reprimand for 'over shooting' his brief. He was transferred to Christchurch, taking charge of the office, and directed to work on the completion of the South Island reconnaissance soil survey. During the 1950s there had been advances in the history of South Island glaciation, of indigenous forests and tussock grasslands, and the impact of climate on soil development. There was also the advent of radiocarbon dating applied to sub-fossil charcoals and wood. Again soil stratigraphy was the key to understanding the complex history of multilayered soils on the plains and in the high county of Canterbury. Planning for the 1962 conference of Commissions IV and V of the International Society of Soil Science (ISSS) at Massey College (now University) saw Colin selecting, sampling and the collecting monoliths of reference soils. The conference field tours were the first of many in which Colin acted as a leader and active participant.

Colin left Soil Bureau in 1965 becoming a senior lecturer in the Geology Department at Victoria University of Wellington (VUW). He developed undergraduate and honours courses in pedology. Post-graduate students soon followed and the rest is history. Colin established an active school of Quaternary stratigraphy based in pedology with an emphasis on the chronology and stratigraphy of tephra and loess cover beds.

The proximity to Soil Bureau's Taita campus enabled Colin to establish close working relationships. Many of his graduate students were sponsored by and subsequently employed as pedologists. He reactivated the collaboration with Alan Pullar, producing key-note papers, in 1969 on the stratigraphy and chronology of late Pleistocene volcanic ash beds in the central North Island and, in 1973 on Holocene tephra formations identified in the Taupo area. This research culminated in presentations at the 1968 9th ISSS Congress in Adelaide and at the 1973 INQUA Congress in Christchurch. The Christchurch meeting and field tours put tephra stratigraphy on the map, highlighting the progress in New Zealand, and the application in related areas of Quaternary studies such as loess stratigraphy and palaeopedology.

Colin widened his experience during VUW Antarctic expeditions in 1967-68, 69-70 and 74-75, and during two periods of sabbatical leave in 1971/72 and 1978 visiting Germany, Japan, north-western United States and Canada, and Colombia.

He retired as a Reader (Associate Professor) from VUW in 1982. In the same year he was awarded the New Zealand Soil Science Society's highest honour, the Norman Taylor Memorial lectureship. Subsequently he became an Associate Lecturer (1984-88) and an Honorary Research Associate (1989-91) in the Department of Soil Science at Massey University. Here he worked with two of his former students, Drs Vince Neall, and Alan Palmer, and was co-supervisor of his last PhD student Brent Alloway. Brent found Colin's input to his study invaluable.

In 1994 Colin was honoured with the C.G. Vucetich Symposium on Tephrostratigraphy and Tephrochronology at the International Inter-INQUA Conference and Workshop on Tephrochrononology, Loess and Paleopedology, held at Waikato University in Hamilton.

Colin Vucetich was a foundation member and secretary of the Rotorua Branch of the Royal Society of New Zealand (RSNZ) in 1954, chairman of the Geology section of the Wellington branch of the RSNZ in 1968, secretary of the National Committee for Quaternary Research in 1970, secretary of an INQUA Tephrochronology Commission in 1973, member of the New Zealand Soil Science Society (NZSSS) and Council member from 1970-72 and 1976-80, New Zealand delegate to the 10th INQUA Congress in Birmingham in 1977, and a Member of the New Zealand Institute of Agricultural Science. Since 1991, Colin has been one of only two (with Ray Wilcox, USA) formal honorary members of the INQUA Tephrochronology Commission (now International Focus Group of Tephrochronology and Volcanism).

He participated in the ISSS congresses in Adelaide 1968 and Edmonton 1978, ISSS Commission IV and V conference in 1962 and the Soils with Variable Charge Conference in 1981 both held at Massey University, and INQUA conferences in Christchurch 1973, Birmingham 1977, Ottawa 1987 and Hamilton 1994. Locally he contributed to NZSSS conferences and the Friends of the Pleistocene field workshops, and the 2004 NZ-INTIMATE (paleoclimate group) workshop.

A few last words from Colin: -

"Alan Pullar and I started as a team in the sense that we were demobbed in 1945-46, a bit older than most soil surveyors and intensely aware of our limited experience"..."By 1955 Alan and I had visited, compared notes, mapped isopachs, and linked Gisborne-East Coast with Kaingaroa mostly in our own time and at our own expense"..."The loss to New Zealand pedologists and soil science of tephrochronology for 40 years has to be recorded."

Colin Vucetich, you have left a lasting legacy to pedology, geomorphology and Quaternary studies, through your own studies, your collaboration with Dr Alan Pullar, and in a vicarious way through the students you supervised and inspired. Thank you, we record our abiding gratitude.

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The completion and time-series analysis of the Lynch's Crater palaeoenvironmental record, northeastern Queensland

SOPHIE C. BRETHERTON (Honours)
Monash University

A sediment core from Lynch's Crater (17°37'S, 145°70'E), northeastern Queensland, was analysed as part of a project to establish a multi-proxy tropical climate and vegetation record that spans at least the last 200,000 years. Developing from extensive prior investigations on the Quaternary history of northeastern Queensland, this study completes the pollen and sediment record of Kershaw (1985).

The extended sequence was correlated with Kershaw's (1985) record through a curve matching approach to obtain a continuous 6585 cm sequence. A chronology was established by comparison with the SPECMAP curve (Martinson et al., 1987), providing a basal age of 220,000 yrs B.P. The complete Lynch's Crater record was subjected to a rigorous spectral and wavelet analysis in order to provide further information of terrestrial vegetation responses to climate change and to determine the degree to which global climate forcing has influenced patterns of vegetation change in northeastern Queensland. The Lynch's Crater palaeoenvironmental record was also compared to the nearby offshore ODP 820 record, as a means of a more regional evaluation of the observed climate change.

The palaeoenvironmental record, together with the Lynch's Crater and ODP 820 computational analyses, shows a consistent glacial-interglacial cyclicity, with interglacials identified by high levels of rainforest angiosperm pollen under high precipitation and temperature levels, and intervening glacials characterised by expansions of sclerophyll vegetation and high levels of rainforest gymnosperms, existing under substantially lower rainfall. Superimposed on this cyclicity are long-term trends, unique events and regional climate influences, such as monsoon and El Niño episodes, which produce a complex pattern of vegetation change through time. The complex dryland vegetation variations were only partly explained by orbital scale climate forcing.

The late Quaternary history of aridity in the Strzelecki and Tirari Desert dunefields, South Australia

KATHRYN E. FITZSIMMONS (PhD)
Australian National University

Linear dunes occupy more than one third of the Australian continent, but the timing of their formation and their reliability as proxies for arid conditions is poorly understood. This thesis investigates the late Quaternary history of aridity of the Strzelecki and Tirari Desert dunefields, a region in the driest part of Australia. This was achieved using a threefold approach. Firstly, the morphologic variability of linear dunefields was investigated, in order to understand dunefield formation over regional scales, and to assess the degree to which local geomorphologic context influences dune response to arid conditions. Secondly, the sedimentological and stratigraphic characteristics of linear dunes were used to interpret the degree to which dune activity can be used as a proxy for aridity. The reliability of dune records, based on evidence for reworking and the extent to which stratigraphy is preserved, was also assessed using this evidence. Finally, the timing of dune activity, interpreted using an OSL chronology, was used to provide a proxy history of late Quaternary aridity within the driest part of the arid zone.

The morphological variability of linear dunes in the Strzelecki and Tirari Deserts of Australia was assessed using a dune classification scheme, based on quantifiable variables of substrate, spacing and junction frequency. The use of high spatial resolution ASTER satellite imagery enabled detailed analysis, including spectral characterisation of substrate, at both local and regional scales. The classification of the linear dunes revealed close relationships between substrate type and dune spacing, reflecting local sediment availability. Both downwind evolution and sediment nourishment from local sources play a role in linear dune formation, although the latter dominates. Maps illustrating the spatial distribution of planimetric variables provide a useful tool for investigating linear dune characteristics, although additional variables such as height, width and dunefield age add to the complexity of dune formation and must also be considered.

The extent to which dunes act as proxies for aridity, and their reliability as palaeoenvironmental archives, was examined by characterising dune sediments, stratigraphy, and evidence for reworking. In the Strzelecki and Tirari Deserts, linear dune activity took place in response to intensified aridity. Clay pellets, which form by the efflorescence of salts on seasonally exposed clay flats with high evaporation rates, were found at several sites, and indicate incipient aridity and periodic inundation of adjacent swales. Their presence and inherent fragility suggests that linear dune sediments are mostly derived from local sources. The similarity of dune and underlying substrate characteristics supports the local windrift model for dune formation.

The reworking of underlying palaeosols within dunes, indicated by abrasion and partial preservation of grain cutans, is ubiquitous across the dunefields. Although not all dunes preserve every identified episode of activity due to local reworking, the widespread sampling strategy adopted in this study reduces bias towards more recently reworked periods.

In this study, 82 samples from 26 sites across the Strzelecki and Tirari Deserts were collected to provide an optically stimulated luminescence chronology for the dunefields. Standard tests for the luminescence behaviour of aeolian quartz, including dose recovery and the measurement of recycling ratios and thermal transfer, showed that the linear dune sediments are well suited to the OSL SAR protocol. The dunes each preserve up to four stratigraphic horizons, bounded by palaeosols, which represent evidence for multiple periods of reactivation interspersed by episodes of increased environmental stability. The OSL chronology was shown using standard statistical tests to contain five distinct age populations, interpreted to correspond to aeolian events, at 73.3-65.8 ka, 34.7-28.7 ka, 22.1-17.8 ka, 14.1-12.1 ka and 11.7-10.0 ka. A cluster of ages from approximately 3.5 ka to the present suggests that dune activity also took place during the late Holocene, but does not form a statistically significant population by the same tests. Stratigraphic evidence suggests that dunes may have been partially active over long periods of time, resulting in slow net

accumulation punctuated by short-lived, substantial sand-shifting events. Dune activity coincided with cold, arid conditions during early marine oxygen-isotope stage (MIS) 4, mid-MIS 3 and the Last Glacial Maximum (LGM), and warm, dry climates during the Pleistocene-Holocene transition and late Holocene. The timing of widespread dune reactivation coincided with dune activity in other dunefields within Australia, although aeolian activity prior to MIS 5, recorded elsewhere, does not appear to be preserved in the Strzelecki and Tirari Deserts. Aeolian events during early MIS 4 and the LGM correlate with increased dust flux to the Tasman Sea and Antarctic ice cap, glaciation in southeastern Australia, cooler regional sea-surface temperatures, and increased ice volumes in the southern hemisphere and Antarctica.

Strontium Isotope Tracing in Animal Teeth at the Neanderthal site of Les Pradelles, Charante, France

TEGAN KELLY (Honours)
Australian National University

Strontium isotope tracing ($^{87}Sr/^{86}Sr$) can be utilised in reconstructing the migration and mobility of ancient animal and human populations. Strontium isotopes in fossil tooth enamel are compared to a geological, bio-available strontium isotope map, to determine whether teeth are from local or migrant individuals. This study was carried out on the Upper Pleistocene site of Les Pradelles (Marillac-le-Franc, Charente, France), which has yielded numerous faunal remains including an important collection of Neanderthal pieces (Homo neanderthalensis). The surrounding area consists of two main rock regions, the limestones of the Dordogne and the metamorphic and granitoid rocks of the Massif Central, which yield differing average strontium isotope ratios. Soil and plant samples were collected from 40 locations across both rock regions. Soil samples were sieved and leached to ensure only biologically available strontium would be measured. Plant samples were dried, ashed and dissolved. All samples had total Sr concentration measured via solution ICP-MS before Sr separation was undertaken via ion exchange chromatography. $^{87}Sr/^{86}Sr$ ratios were measured via ICP-MS analysis. Despite some variation in $^{87}Sr/^{86}Sr$ within each rock region, the two main regions are successfully differentiated on the basis of Sr isotopes and a Sr isotope map of the area has been produced. The fossil faunal samples from the site consisted of 27 teeth from seven species including both herbivores and carnivores. Sr isotopes in the tooth enamel were measured via laser ablation ICP-MS, resulting in high resolution records along the growth axis of the enamel. The strontium isotope ratios do not vary greatly along the growth of the tooth enamel, potentially indicating a lack of migration across the rock provinces while the teeth were forming. However, the lack of seasonality may alternatively be explained by reservoir effects and complexities in tooth mineralisation. Animals with small feeding ranges are successfully linked to particular rock regions according to Sr isotope ratio, whereas intermediate $^{87}Sr/^{86}Sr$ values in migrating animals suggest an averaging of values from both units. This study forms the basis for an ongoing study into Neanderthal migration.

Cenozoic Glacial History and Landscape Evolution of Mac.Robertson Land and the Lambert Glacier-Amery Ice Shelf System, East Antarctica

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The response of the East Antarctic Ice Sheet (EAIS) to past changes in global climate and sea level provides important information on the behavior of this, and other large ice sheets. Former ice sheet geometries are also invaluable for determining the reliability of numerical ice sheet models under climatic conditions that differ from those of today. In turn, this increases our understanding of how accurately these models predict future ice sheet geometry and sea level change.

The marginal extent of the EAIS is reasonably well constrained by field evidence from the continental shelf. However, there is little field evidence for former ice sheet heights, and the dating of ice-sheet expansions on the continental shelf is equivocal. This thesis aims to address this problem in three areas: to understand how the formation, preservation and cosmogenic exposure dating of glacial landforms is affected by climatic gradients in Antarctica; to document changes in the height of the ice sheet in the Lambert Glacier-Amery Ice Shelf system (LG-AIS) during the Cenozoic and date these changes using cosmogenic exposure dating; and to investigate whether or not regions of the ice sheet where ice flow is dominated by ice streams respond differently to areas where ice streams are not present.

The distribution of modern geomorphic processes in the Prince Charles Mountains (PCMs) indicates that the rate and abundance of the melt-based processes such as fluvial, lacustrine and mass movements decrease with increasing altitude, in accordance with the decrease in surface air temperature due to the adiabatic lapse rate. This corresponds with a decrease in the rate of surface boulder weathering, and a decrease in glacial erosion with decreasing ice thickness, resulting in a much more rapid production and reworking of moraines at low altitudes. These observations have significant implications for the interpretation of the presence and absence of moraines across the region. Also, the rates of glacial erosion are low enough that the cosmogenic exposure history of neither bedrock nor sediment surfaces will be reset during a single glacial advance, so the interpretation of exposure age results must include the likelihood that a significant proportion of clasts will have inherited cosmogenic nuclides from a previous period of exposure.

The moraines present (and absent) in PCMs provide evidence that the height of maximum ice advances in the LG-AIS has decreased during the mid-late Pleistocene, in concert with similar reductions in the maximum expansion of the ice sheet onto the continental shelf. This decrease is potentially an Antarctic-wide phenomenon, and rate of ice retreat is much greater than would have occurred from the glacial modification of the regional topography, suggesting that climatic forcing is responsible for this shift. This is perhaps related to the mid-Pleistocene transition from 41 ka to 100 ka climate cycles, although southern hemisphere temperature records are not presently accurate enough to discern if this reduction in ice volume was influenced by changes in air or ocean temperature.

Dating of moraines, bedrock surfaces and erratics also indicate a difference in the timing of ice downwasting in areas dominated by the two different types of ice flow that drain the EAIS following the LGM. The shape of the maximum ice height during the last glacial cycle indicates that the northern reaches of the LG-AIS were dominated by ice streaming, and cosmogenic exposure dating indicates that deglaciation occurred from 15 ka BP to 11 ka BP. This contrasts strongly with the timing of deglaciation in areas of ice sheet flow, where ice retreat occurred from 12 to 7 ka BP. This difference is attributed to the enhanced sensitivity of areas of ice streaming to ice-shelf bottom melt, and hence air and ocean temperature changes. As this sensitivity is not generally accounted for in the present generation of ice sheet models, these models may under-predict the rate of ice loss from the EAIS over the next few centuries.

Recent publications

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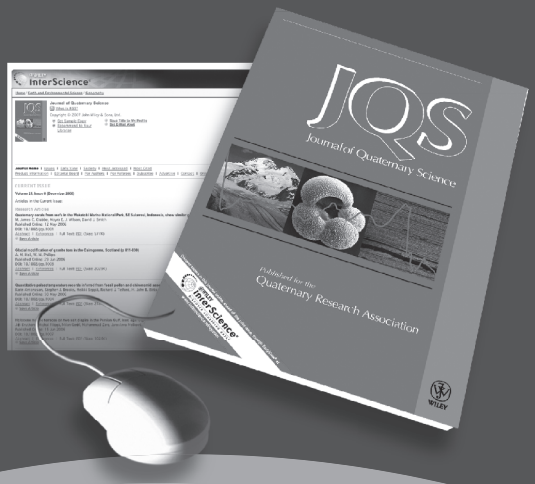

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