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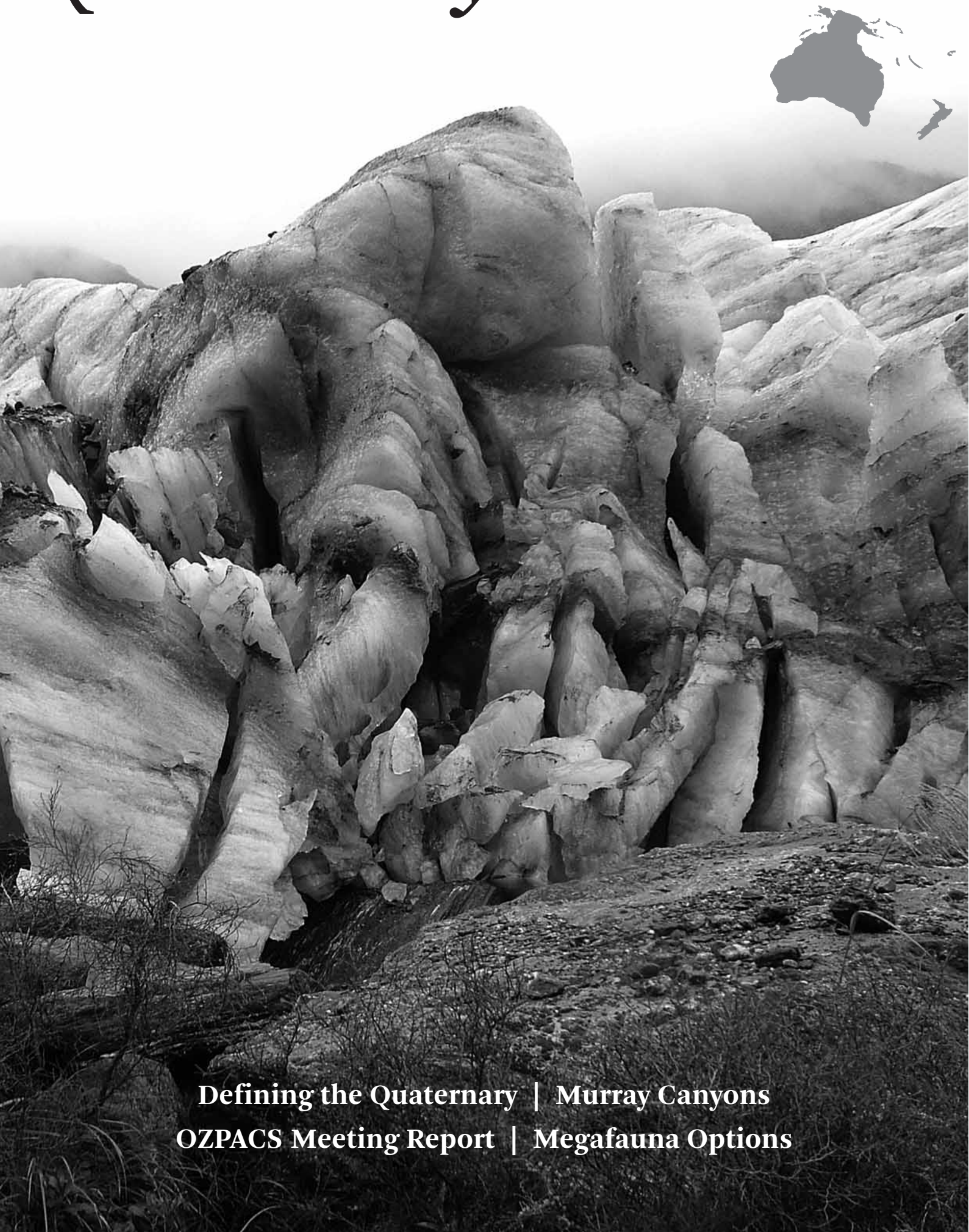
Quaternary AUSTRALASIA



Defining the Quaternary | Murray Canyons
OZPACS Meeting Report | Megafauna Options

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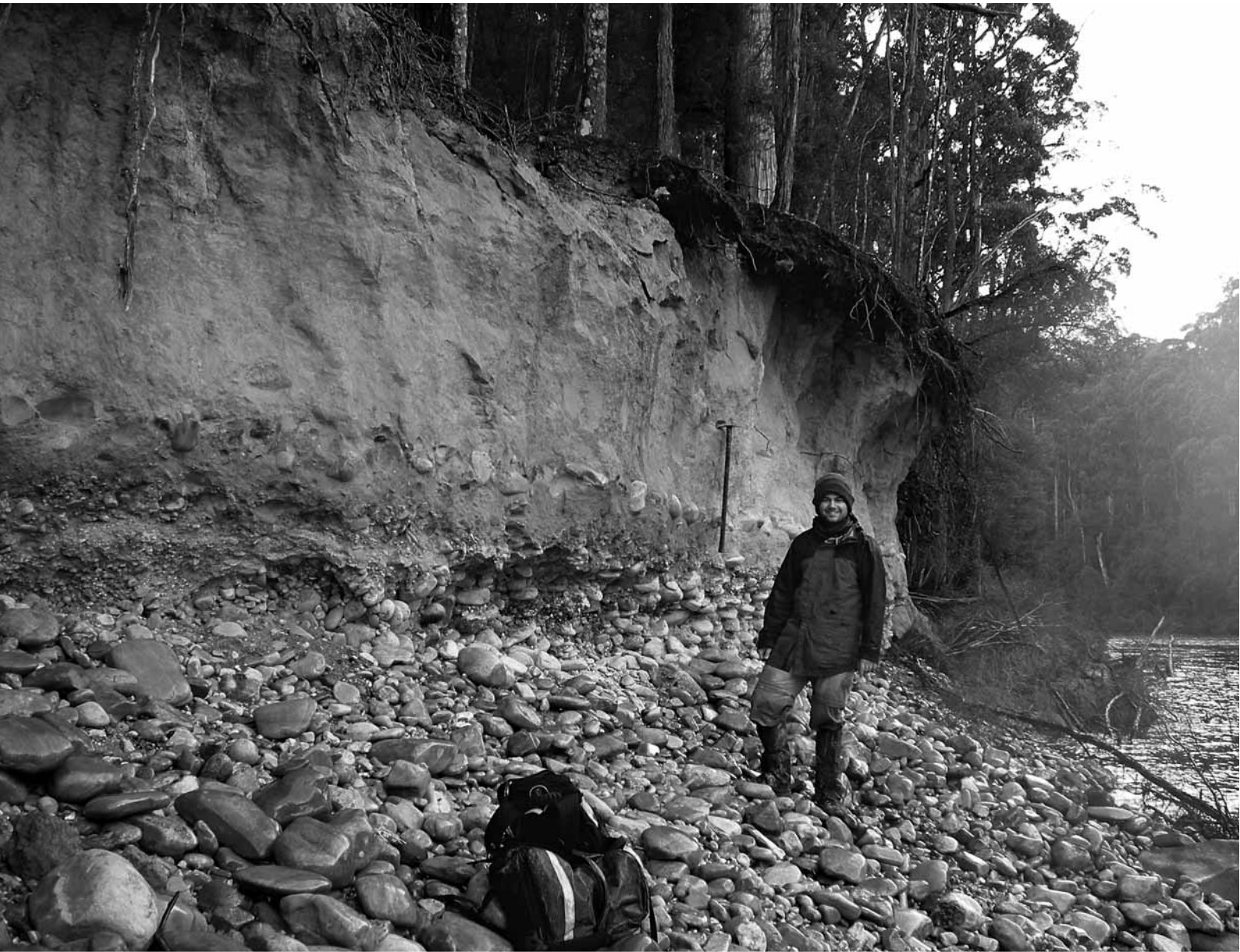
Quaternary AUSTRALASIA

COVER Cover Fox Glacier, South Island, NZ. Correspondent Alan Williams, Senior Archaeologist at HLA Envirosciences Pty Ltd in Gordon, NSW, writes "During my studies in Quaternary Science, three papers that always needed to be considered when discussing the synchroneity vs. asychroneity debate were those of the Franz Josef Glacier and Taylor Dome, due to these records containing the Younger Dryas stadial, hence implying sychroneity. Since I am a firm believer in asynchroneity, I treated these papers as my nemeses (no offence intended to Denton, Hendy, Grootes or Steig) and the term "Franz Josef" was a *faux pas* around my student dorm. Finally, I managed to visit both Fox and Franz Josef Glaciers (and give them a good kick!).

BELOW Adrian Slee in front of a riverbank on the Huon River, Tasmania, showing sandy aeolian sediments dated at c. 34 ka BP by thermoluminescence dating (D.M. Price, University of Wollongong) overlying terrace gravels of presumed early last glacial age, overlying glacial till (not visible). The surrounding area was the subject of Adrian's thesis on Quaternary deposits. Photo: P.D. McIntosh.



EDITORIAL

This is my seventh issue as editor of *Quaternary Australasia*. Although it has been an education and a pleasure editing *QA*, I am afraid this must be the final issue that I will produce. AQUA thus will over the next few months have the task of replacing my position, and also that of its Vice President, because Brent Alloway is departing from GNS in New Zealand in order to take up exciting work in Ecuador (see news).

To my mind, the most arresting item in this issue is Brad Pillans' latest report on the ongoing debate over the status of the Quaternary. To my surprise, the Leuven 2005 proposal (described by Brad in *QA* 23(2)) was rejected earlier this year by INQUA, yet negotiations between INQUA and the ICS continue. Based on Brad's report, it seems possible, again, to imagine that we may eventually see both the Quaternary *and* the Pleistocene formally defined at c. 2.6 Ma, a combination that the Leuven proposal had forsworn. If so, this apparently emboldened Quaternary stratigraphy may dovetail neatly with Hilgen et al.'s recent (2006, *Earth Science Reviews* 74:113) proposal for the revival of the unit stratotype, in the late Neogene context of astronomically calibrated deep marine successions. This approach, in which renewed emphasis is placed on both the boundaries and the (astronomically tuned) physical content of a unit stratotype, has been echoed recently in a proposal by Cita et al (2006, *Episodes* 29:107) for formal definition of Calabrian (Early Pleistocene – here employing the 1.8 Ma lower boundary) and Ionian (Middle Pleistocene- 0.78 – c. 0.13 Ma) stages.

Thus, if efforts to extend the Pleistocene to 2.6 Ma are successful, we will be faced with a two fold, informal, "Early Pleistocene" including the Gelasian and the Calabiran Stages, which we might think of as the "Really Early Pleistocene", and the Merely Early Pleistocene. To my mind, it would be difficult to refer to the Calabiran as the 'late early Pleistocene', since I am already accustomed to referring to the several-100kyr-long interval of transitional climate (neither 41 kyr nor 100 kyr world) preceding the Matuyama/Brunhes boundary, as the 'late Early Pleistocene'.

Also in this issue, Judith Field provides the results of her straw poll of Quaternary scientists on their views of megafauna extinction; Colin Murray-Wallace provides some details about INQUA 2007; Patrick De Deckker describes research on the offshore Murray Canyons; the Recent Human Impacts on Australian Ecosystems working group reports from their April meeting in Canberra; a review by Richard Gillespie of Chris Turney's new book about old rock stars, and several postgraduate thesis abstracts. In addition, the inaugeral QA centrefold describes some of the work of Rachel Peachey and Paul Mosig as artists in residence in the Department of Archaeology and Natural History at ANU.

Cordially, **Kale Sniderman**

PRESIDENT'S PEN

Dear Friends of the Quaternary,

Short but not so sweet Part II

Looking through some old issues of QA, I came across Vol 20(1) 2002 and was reminded by the words of the then President Simon Haberle that much work goes into producing high quality QAs. Our editor over the last three years, Kale Sniderman has decided that it is time to hand over the baton to someone else. The AQUA executive would like to thank Kale for all his efforts to lift the quality of QA yet again. It is also with some sadness that we must announce that Brent Alloway, our Vice-President has left us for the Amazonian jungle. The committee would like to thank him for his involvement and for bringing the two sides of the Tasman closer together, resulting in a large NZ contingent attending the Cradle Mountain AQUA Conference.

On the INQUA 2007 front I would like to invite you to have a look at the website: *www.inqua2007.net.au*, and register your intent to come to Cairns next year. The program is taking shape and there are some very interesting fieldtrips coming up.

The executive has decided not to have a bi-annual AQUA meeting. Originally the meeting was to be held in New Zealand, but with the departure of the organiser Brent Alloway to South America this became impossible. With a large financial commitment and involvement of AQUA committee members with the INQUA 2007 organising committee, it was deemed wiser to focus on that. We have asked for a special AQUA session at INQUA to showcase Quaternary research in Australia.

On behalf of John Chappell, I attended the Australian Academy of Sciences – National Committees Chair meeting in Canberra last April and reported on the efforts that Quaternarists had put into the successful bid to host the INQUA 2007 conference, and on the establishment of an organising committee for that conference.

Yours Quaternarily, **Henk Heijnis**

Defining the Quaternary: where do we go from here?

Brad Pillans
President, INQUA Stratigraphy & Chronology Commission

One can only agree with sentiments recently expressed by the eminent stratigrapher Amos Salvador: "A stable, standard geologic time scale is indispensable for the clear and precise communication among geologists" (Salvador 2006, p.43). Indeed, this is exactly the task of the International Commission on Stratigraphy (ICS), expressed through the most recent iteration of the international Geological Time Scale, GTS2004 (Gradstein et al. 2004). However, as I have discussed in recent issues of *Quaternary Australasia*, the definition of the Quaternary has been much debated, and remains anything but stable in the GTS.

To my mind, the most significant obstacle to formalizing and stabilising the Quaternary as a chronostratigraphic unit in the GTS has been the lack of agreement on what actually constitutes the Quaternary, particularly its duration. The same could be said for the Pleistocene. To illustrate this point, the figure summarises the ways in which the Quaternary has been defined in the last three international Geological Time Scales (GTS1982, GTS1989 and GTS2004), compared with what I will refer to as the Salvador 1994, Leuven 2005 and INQUA 2006 proposals. Another proposal, by Pillans & Naish (2004), to define the Quaternary as a Subsystem of the Neogene is not illustrated. Note the complete lack of stability concerning both rank and duration.

It seems that in GTS2004 the ICS considered that the terms Quaternary and Tertiary were somewhat archaic and therefore should be abandoned. The four-fold subdivision of rocks into Primary, Secondary, Tertiary and Quaternary was first introduced in 1759 by the Italian mining engineer, Giovanni Arduino. However, since Primary and Secondary had long ago been abandoned in favour of Paleozoic and Mesozoic, one could argue that it was a neat and tidy approach by ICS to also drop Quaternary and Tertiary. Admittedly, GTS2004 shows Quaternary as an informal "climato-stratigraphic" unit spanning the last 2.6 Ma of the Neogene, but Quaternarists saw this as a significant betrayal, without proper consultation with INQUA.

Remember that the base of each chronostratigraphic unit, which makes up the hierarchical structure of GTS, is defined (or in the process of being defined) at a specific nominated point (the so-called "golden spike") in type sections, called Global Standard Sections and Points (GSSP's). The concept of defining chronostratigraphic units by defining their bases at a specific point in a nominated type section can be traced back to the International Geological Congress in London in 1948. At that congress, it was recommended that the Plio/Pleistocene boundary be defined in a suitable section "at the first indication of climatic deterioration in the Italian Neogene succession" (King & Oakley 1949).

Unfortunately, a GSSP (Vrica section in Italy) was not agreed upon and ratified until 1984, and its age was subsequently accurately determined to be 1.806 Ma by astronomical calibration (Lourens et al. 1996).

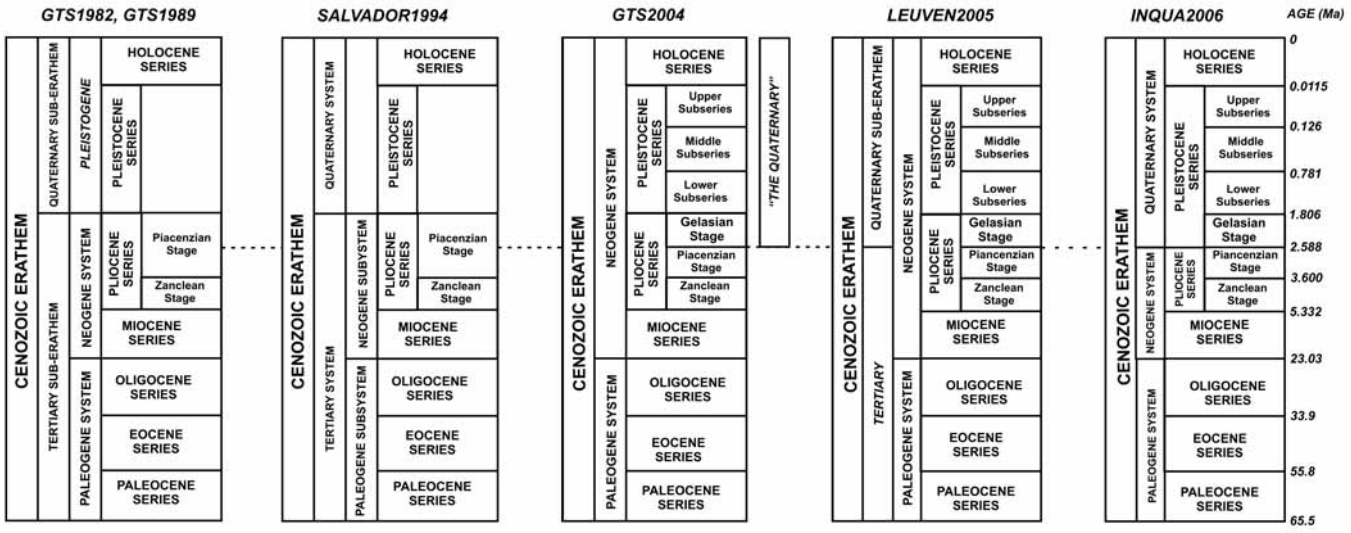
In the period between 1948 and 1984, the base of the Pleistocene (= base of Quaternary) was recognized in sections around the world on the supposition of a single major global cooling that heralded the "ice ages". So, for example, the base of the Pleistocene was identified in New Zealand on the basis of the incoming of subantarctic faunas (including the scallop, *Zygochlamys delicatula*) to Wanganui Basin (Fleming 1953), and also on floral evidence of cooling (e.g. Stipp et al. 1967), in both cases at stratigraphic levels that we now know to be significantly older (about 700 ka older) than the Pleistocene GSSP in Italy (Naish et al. 1998). Similar reasoning resulted in the climatically defined Plio/Pleistocene boundary being recognized at around 1.8 Ma in deep sea cores (e.g. Glass et al. 1967), but around 2.6 Ma in European glacial deposits (e.g. Zagwijn 1992). The end result was confusion over the age of the Plio/Pleistocene boundary and by implication, the duration of the Quaternary. Adding to the confusion was the statement by Aguirre & Pasini (1985, p. 116) that "the subject of defining the boundary between the Pliocene and Pleistocene was isolated from ... the status of the Quaternary". In other words, Aguirre and Pasini specifically avoided a formal definition of the Quaternary.

I could go on with history, but let's come to the events of the past two years...

Leuven 2005 and Ahmedabad 2006

In September 2005, after much discussion between INQUA and ICS, including a joint working group, the full voting membership of ICS made the following recommendations at an ICS meeting in Leuven, Belgium:

1 That the Quaternary be established as a formal chronostratigraphic (geochronologic) unit of the Cenozoic Erathem (Era).
2 That the Quaternary span the past 2.6 myr of the Cenozoic Erathem/Era, with its formal base at the



GSSP of the Gelasian Stage/Age of the Pliocene Series/Epoch.

3 That the Quaternary have the rank of Sub-Erathem (and Sub-Era) in the geologic time scale, and be coeval with the uppermost portion of the Neogene System (Period).

The Leuven recommendations were submitted to INQUA for their formal acceptance. However, at the INQUA executive meeting in Ahmedabad in March 2006, following further polling of INQUA members and Quaternary national committees, INQUA rejected the ICS recommendation to define the Quaternary as a Sub-Era/Sub-Erathem. The stated reasons for rejecting the ICS recommendation included its non-hierarchical nature, the decoupling of the Quaternary from the base of the Pleistocene, and the extension of the Neogene to the present.

In reply, INQUA has proposed that the Quaternary should be defined as a Period/System above the Neogene, and that the base of the Pleistocene be redefined at the Gelasian GSSP (to also correspond with the base of the Quaternary).

Where do we go from here?

In my opinion (see also Aubry et al. 2005) the Leuven proposal to define the Quaternary as a Sub-Era with duration 2.6 Ma has several things in its favour:

1 It separates the definition of Quaternary from arguments about the definition and duration of the Pleistocene and Neogene, both of which have been somewhat contentious issues.
2 It satisfies the INQUA desire to see the Quaternary as a formally defined unit of the GTS, with a duration (2.6 Ma) that is favoured by the majority of Quaternary scientists.
3 It utilizes an existing GSSP (Gelasian Stage).
4 It requires minimal change to GTS2004.
5 It allows reintroduction of "Tertiary" to GTS, a term that still has wide stratigraphic usage, particularly in Australia.
6 It recognizes the differing origins and usages of the terms Neogene/Palaeogene and Quaternary/Tertiary, with the former most commonly used in marine sequences, and the latter in continental sequences.

On the other hand, the Leuven proposal has some perceived weaknesses:

1 There are no other Sub-Erathems/Eras in the GTS, so it would create a new level in the hierarchy. I don't see this as a particular problem – there are only two Subsystems in GTS (Mississippian and Pensylvanian Subsystems of the Carboniferous), but that does not limit their utility as valid, formally defined entities of the GTS.
2 The Quaternary Sub-Erathem/Era would create a non-hierarchical point in the GTS. That is to say, the proposed Tertiary/Quaternary boundary would not correspond to a boundary at System or Series levels. Many people regard this as a major problem. However, I regard it as a practical necessity that recognizes the differing origins of the terms Quaternary and Neogene.
3 The base of the Quaternary would not correspond to the base of the Pleistocene. There is a long tradition of equating the base of the Pleistocene with the base of the Quaternary, although, as pointed out by Aubry et al. (2005), the two terms had quite differing origins and meanings. To align the two, either the base of the Pleistocene must be lowered to 2.6 Ma (= Gelasian GSSP), or the base of the Quaternary must be raised to 1.8 Ma (= Pleistocene GSSP). Given the majority view

that the base of the Quaternary should be at 2.6 Ma, only the former of these options appears viable. However, a previous attempt to lower the base of the Pleistocene was unsuccessful, resulting in re-ratific-ation of the Pleistocene GSSP in 1998. A ten year moratorium on ratified GSSPs means that any further attempt to change the Pleistocene GSSP cannot be made until after 2008.

Concluding remarks

The majority of Quaternarists regard the Quaternary as most logically beginning at ~2.6 Ma (see also Pillans & Naish 2004). This point is accepted in both the Leuven2005 and INQUA2006 proposals and should be the starting point for moving towards a resolution of seemingly disparate views between INQUA and ICS. There is also agreement that Quaternary must be defined as a formal chronostratigraphic unit.

At the most recent ICS meeting which I attended (at Schloss Seggau, near Graz in Austria in June 2006), there was general agreement that INQUA and ICS must continue their negotiations on the definition of the Quaternary. This agreement, I think, reflects a growing realization within ICS that it cannot afford to alienate the large Quaternary community. I note also, that as of this year INQUA is a full member of the International Council of Scientific Unions (ICSU), whereas previously it came under the umbrella of the International Union of Geological Sciences (IUGS), which is also the parent body of ICS. Thus, the Quaternary is the only portion of the GTS to have its own Union, and INQUA is now of equivalent status to (and independent of) IUGS.

The upshot is that whereas previously there was an element of "take it or leave it" from ICS in relation to the definition of the Quaternary, INQUA can now expect to negotiate on a more even footing. With this in mind, ICS will continue to display the Quaternary as spanning the last ~2.6 Ma on all its official time scales, with a footnote to explain that a decision on its rank has not yet been reached. A possible next step (in 2008) would see INQUA making a case to IUGS and ICS for moving the Gelasian Stage from the Pliocene to the Pleistocene, and thus lowering the base of the Pleistocene to 2.6 Ma, coinc-ident with the base of the Quaternary. This could then be followed with a proposal to define the rank of the Quaternary as System/Period above the Neogene. Whether such proposals would be successful remains to be seen. However, we seem to be entering a new phase in the negotiations between INQUA and ICS, and I remain optimistic that a "peace settlement" will ultimately be reached to provide the nomenclatural stability that Amos Salvador and indeed all of us are seeking.

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The Megafauna Extinction Straw Poll

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As happens periodically, a new finding or new research reignites the megafaunal extinction debate in the media. Views are expressed, positions taken and the general public is again entertained by someone's five minutes of fame. Recently, Richard Gillespie and Barry Brook published a paper in *Archeology in Oceania* (41, 1–11) which was followed up by an article in the popular science magazine *Australasian Science* (Brook, Gillespie and Martin, June Issue, 35–37, but see Field *et al*, July issue, 28–29). The paper questions the place of the Cuddie Springs site in the current arguments concerning the nature and timing of the megafaunal extinctions in Australia. In an article published in the Sydney Morning Herald, *Aborigines were no giant killers, say scientists* by Deborah Smith, 5th June, 2006 (which reported on the Brook/Gillespie article and on a recent publication in *Quaternary Science Reviews* by Wroe and Field proposing an alternative extinction model), it was implied that Steve Wroe and I were the only two people suggesting that humans may not be responsible for the extinction process. Barry Brook was quoted as saying "... the consensus among Australian scientists was that Aborigines had been mostly responsible for the extinctions." On reading this, it occurred to me that nobody (that I was aware of) had actually asked the question directly of people in the discipline. In response, I took it upon myself to post these two questions on the AUSARCH and AQUA lists to 'test the water' (and I would remind everyone that this is just a straw poll and I have no pretensions about it being a comprehensive or unbiased sample).

The two questions were: 1: Do you agree with the statement by Barry Brook? and 2: Do you believe that Aborigines were mostly responsible (by whatever mechanism) for the extinctions? (read megafauna here)

In the end I received a total of 85 responses; the numbers below vary a little from the numbers posted earlier on the AUSARCH/AQUAlists, because I double checked my quick counts and had got some wrong. While I asked for yes/no answers, many people, particularly the archaeologists, gave me essay-like replies. Following are tables that summarize the responses. I split the respondents into three groups: *earth scientists*, which include geochronologists, geomorphologists, botanists, etc; *archaeologists*; and *unknown*, where the profession of the respondent wasn't indicated. I know a lot of people didn't respond and I presume it was because of either the narrow scope of the question and/or they couldn't be bothered getting involved in what must seem like a storm in a teacup in the grand scheme of things.

All Respondents (Total 85)

QUESTION	YES	NO	UNDECIDED/ DON'T KNOW	TOTAL
1	11	68	6	85
2	11	64	10	85

Earth Scientists (Total 28)

QUESTION	YES	NO	UNDECIDED/ DON'T KNOW	TOTAL
1	8	18	2	28
2	7	16	5	28

Archaeologists (Total 51)

QUESTION	YES	NO	UNDECIDED/	TOTAL
1	3	45	3	51
2	3	44	4	51

No profession stated (Total 6)

QUESTION	YES	NO	UNDECIDED/	TOTAL
1	0	5	1	6
2	1	4	1	6

There is an overwhelming NO response to the notion that there is a consensus amongst scientists (remembering that I have assumed Brook means those working in related fields to the extinction problem); and NO not everyone accepts the argument that people were mostly responsible for the extinctions of the megafauna. The straw poll drew so many responses that I suspect that even if the net was cast over a wider audience that the results would be roughly the same.

Of those who replied in a more lengthy form, some of the (paraphrased) comments were: ... *there is a lack of evidence to support a human-causation scenario ... there is a lack of evidence to support a climate change model ... there is a paucity of sites where any model can be tested ... the fossil record is poorly constrained ... humans may have been 'the straw that broke that camel's back' ... human causation: don't necessarily agree, but it is the best working hypothesis ... people were responsible, but there weren't Aborigines yet, just recent immigrants.*

My take on all of this is that most people see the evidence presented so far as too sparse to be able to make a definitive statement on any particular scenario. A higher proportion of earth scientists than archaeologists supported Barry Brooks's statement, but those that said no to both statements marked the majority in all groups. The megafauna extinction debate will be making headlines for years to come. It will be interesting to test the waters once more, in a couple of years time, to see if views are changing or remain the same.

Geological and biological investigations of the Murray Canyons Group Cruise SS02/2006

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We have successfully completed the mapping of some of the deep-sea canyons that was commenced during the AUSTREA and AUSCAN cruises on the *L'Atalante* and *Marion Dufresne* vessels in 1999/2001 and 2003 respectively. As a result, we now have a high-resolution map of the Sprigg Canyon. We have identified that some of the conduits (channels of the preliminary map, see figure opposite) are definitely used for transporting upper slope material downwards. Additional investigations will be carried out in the laboratory at the ANU. We found, by attempting to core the large, deep holes located at great depths [> 4.5km] below the canyons that they are not sites of substantial sedimentation. In addition, we did not find any hydrochemical anomaly that could have been generated by fluid/gas emission, although we did not manage to rest the CTD (conductivity-temperature-depth profiler) equipment on the floor of the holes.

In addition, we located the position of ancient courses of the Murray across the Lacepede Shelf and discovered the presence of a large lake that would have been dammed by outcrops and possibly a large dune field. A map of the extent of the lake and associated prodelta, dune fields and various courses of the river system was completed. Unfortunately, we did not manage to retrieve cores from the Lacepede Shelf that would help us confirm our discovery as a thin, hard layer consisting of medium fine, brown sand covered the entire Lacepede Shelf. We anticipate that the lake occurred at approximately the 60m isobath.

We could only trace the ancient courses of the River Murray for the last glacial-interglacial period. No evidence was found for much older geomorphic features, assuming either that they were eroded away or that the sub-bottom profiling equipment did not permit us to penetrate deeper into the sedimentary sequences.

However, in most cases, recognised fluvial features did sit directly on the basement. We also found evidence of an ancient drainage system on the shelf opposite the Glenelg River that will deserve further investigations .

Photographs showing the corer that is on the rear deck and people extracting tube full of sediments from the inside of the canyons. In the top photo Dan Wilkins is on the left holding one section of the core, in middle is Patrick De Deckker and to the right is Nigel Craddy, all of ANU. Lower photo shows Patrick and Nigel undoing the corer. The sediments, once analysed, will tell the story of changes that occurred in the canyon and also about discharges of the River Murray through time. Photographs: Doreen Rossler.

Three dimensional view of the Sprigg Canyon southeast of Kangaroo Island.
Obvious are the undersea meanders that feed the canyon in the bottom right hand side of the canyon. Canyon depths exceed 4000 m. Imagine dense flows of water with muds and sands cascading down those channels and this is a way to engender those erosion features. Map generated by Mr Michele Spinoccia from Geoscience Australia who was on board the vessel. The white represent gaps in the mapping. There is no copyright for this picture that may appear grainy but this is limited by the data gathered by the swath mapping equipment on the ship. The overall topography is reminiscent of what we know in the Blue Mountains, but the relief under the sea is more than four times bigger. We believe that the canyons are often visited by whales and fish due to the constant upwelling of cold, nutrient-rich waters from the abyss.

As a separate project, De Deckker was able to use an air filtering apparatus in the front of the vessel aimed at trapping sufficient material for microbiological analysis from the ambient air. On one occasion, a sample was taken during a minor dust storm that reached the ship when it was close to the South Australian coastline. Material is now being analysed at the ANU in the microbiological laboratory of Dr G. Allison.

We obtained good CTD data down to great depths (>5,000m) in the canyons (perhaps the deepest CTD obtained with the Southern Surveyor) and these will prove very useful for future research on deep water.

CONCLUSIONS

1 We have a better understanding of the nature of the deep-sea canyons offshore Kangaroo Island. These sites are likely to be visited by cetaceans and will be of use to future biological surveys in the region.

2 We have found ancient lacustrine deposits that have the potential, if cored, to provide information on past climatic regimes that affected Australia during a very wet period coinciding with the filling of the Willandra Lakes (e.g. Mungo) and the extensive river flows registered in the Murray Darling Basin.

3 We have mapped possible ancient courses of the ancestral River Murray offshore Portland and discovered significant undersea slides that potentially could cause tsunamis.

4 We have commenced a program of filtering air at sea to determine the nature of aerosols and identify their microbiological contents.

FILTERING REMNANTS

VISIBLE TRACES + THE CULTURAL LANDSCAPE

The Synapse Art and Science Residency Program builds new creative partnerships between scientists and artists, science institutions and arts organisations, and is managed by the Australian Network for Art and Technology. From May to August 2006 new media artists, Rachel Peachey and Paul Mosig are working with The Department of Archaeology and Natural History at The Australian National University.

The focus of the program is on multidisciplinary collaboration, research and development, which may lead to outcomes including publications, forums and exhibitions. Rachel and Paul will spend twelve weeks living and working at the ANU developing a body of work that reflects the meticulous gathering and documenting of samples that occurs in the study of Palaeocology and the consequent story telling that makes the study of human environment interactions through time so interesting.

Rachel and Paul's research will concentrate on the Holocene period and more specifically European impact on the environment in the context of the Snowy Mountains region of NSW. Using the mediums of light and sound through photographs, video, film, shadow, projection, light microscopes, field recordings and oral histories, Peachey and Mosig aim to create multi-layered spatial environments.

Rachel and Paul will produce a series of objects, projections and soundscapes to create an installation in space that seeks to compress time. They will layer images from pollen samples and historical texts with present day plant samples and photographs to immerse the viewer in an environment that looks at human action in relation to their environment and the consequences of these actions.

The flexibility of light mediums ensures that iconic imagery such as bogong moths, cows grazing, pollen samples, hydro-electric system schematic drawings, scanned plant samples and the like may be arranged in a variety of ways to gain different perspectives on the relationships between past and present.

Rachel and Paul's process seeks to mimic that of the scientists they are working with, researching the area they are interested in, taking samples from the environment, processing them using highly refined technological methods and then using the results to create 'stories'. However while science emphasises the need to be objective, the visual arts can use 'facts' for inspiration while developing work with a very specific opinion or moral standpoint.

For more insight into this project you can view Rachel and Paul's blog at this address:

www.thecontextualvillains.org/synapse

This project has been assisted by the Australian Government through the Australia Council, its Arts funding and Advisory body.

OZPACS:
Recent Impacts on Australian Ecosystems
Australian National University, Canberra, 20–21 April 2006

ABOUT OZPACS

OZPACS is a working group focused on human impacts on the Australian environment over the last 500+ years, and is intended to provide a forum for constructive dialogue with natural resource managers. The OZPACS project is not for primary research but instead seeks to build a research network, collate existing research efforts, identify and prioritise knowledge gaps, provide early career initiatives and enhance our research environment and potential.

The aims of the project are:
- To assemble palaeoenvironmental data covering the last 500 years for Australia and establish an accessible spatial database (GIS-based);
- To document ecosystem change over the last five centuries to aid managers formulate targets for restoration and assess heritage significance;
- To assess the range of technologies available to reconstruct human impacts on the environment over the last 500 years;
- To share experiences of techniques used in short term palaeoenvironmental studies in order to develop 'best practice' protocols;
- To establish a list of high priority sites, i.e., those of greatest potential, in order to help future researchers contribute to a more comprehensive assessment of recent human impact across a wide range of Australian ecosystems.

The OZPACS working group is funded through the ARC funded 'Environmental Futures Network' (EFN) (see http://nesuab.ees.adelaide.edu.au/). The OZPACS project is the Australian contribution to the PAGES Focus 5 project (see: *http://www.liv.ac.uk/geography/PAGESFocus5/aboutF5.htm*). Whereas PAGES Focus 5 currently contains three separate projects (HITE, LIMPACS, LUCIFS), OZPACS integrates aspects of each to focus on recent human impacts, using a wide variety of palaeoenvironmental archives and proxies.

The EFN has a strong 'past for present and future' theme and a 'deeper' time focus, however OZPACS was deliberately envisaged as a project relating to short-time scales.

Over its initial three years, OZPACS will hold a series of workshops, contribute to a special PAGES Focus 5 session at INQUA 2007 and sponsor a major conference (in 2008). The tangible outcomes of the OZPACS working group will include:
- Making available a comprehensive spatial database of palaeoenvironmental research covering the last 500+ years;
- Developing 'best practice' protocols for different types of site, environment and investigation;
- Developing multi-disciplinary research applications to investigate sites with the greatest potential for understanding environmental change in different regions of Australia over the last 500 years;
- Identifying ecosystems that are most responsive/sensitive to human impact;
- Fostering greater interaction and mutual understanding between the palaeoecological community and natural resource managers; and,
- Publication of a Proceedings of a National Conference on Human Impact on Australian Ecosystems (under the banner of IGBP Pages Focus 5)

OZPACS WORKSHOPS AND EVENTS

The first major OZPACS workshop was held over two days at the Australian National University in Canberra (20–21 April, 2006). Researchers from a broad range of fields, including palaeoecology, dating and archaeology, were in attendance and presented. The workshop was designed to provide an overview of the techniques and methods used to document environmental change over the last 500+ years in Australia. Presentations included:
- **Introduction to OZPACS and aims of the meeting** Scott Mooney, UNSW and Sophie Bickford, CSIRO;
- **Estuarine palaeolimnology and eutrophication** Kathryn Taffs, SCU and Gus MacGregor, U.Adel.;
- **Past fire regimes: Australian fine resolution palaeoecological datasets** Scott Mooney, UNSW);
- **Fine resolution multi-proxy analysis, including pollen** Simon Haberle, ANU;
- **Forams and charophytes** Adriana Garcia, UOW;
- **Terrestrial and freshwater macrofossils** Nick Porch and Tara Lewis, Monash;
- **Recent ^{14}C** Quan Hua, ANSTO;
- **^{210}Pb and ^{137}Cs** Gary Hancock, CSIRO;
- **Other (recent) chronological tools** Stephen Gale, U. Syd.;
- **Geochemical proxies** Allan Chivas, UOW;
- **Recent OSL** Gary Hancock, CSIRO; and,
- **Integrating multiple profiles and proxies** Matiu Prebble, ANU.

Afternoons were set aside for discussion, particularly of issues associated with aims 1, 4 and 5 (listed above). Much discussion focused on 'best practice' and the identification of sites with the best potential for providing high-resolution (sub-decadal) multi-proxy environmental reconstructions for the last 500+ years.

Additionally, there was extended discussion on how to establish and make accessible the spatial database. Of note here, members of the working group were identified to co-ordinate the compilation of different aspects of the spatial database:

- **Charcoal and fire**
  Scott Mooney: *s.mooney@unsw.edu.au*;
- **Intersection of archaeology and palaeoecology**
  Tim Denham: *Tim.Denham@arts.monash.edu.au*;
- **Fine resolution pollen**
  Simon Haberle: *simon.haberle@anu.edu.au*;
- **Phytoliths** Carol Lentfer: *c.lentfer@uq.edu.au*;
- **Recent dating** Jennifer Harrison: *jjh@ansto.gov.au* and Gary Hancock: *gary.hancock@csiro.au*;
- **Sedimentological records**
  Stephen Gale: *sgale@mail.usyd.edu.au*;
- **Charophytes, etc**
  Adriana Garcia: a*driana@uow.edu.au*;
- **Diatoms** Mike Reid: *Mike.Reid@canberra.edu.au*;
- **Macrofauna**
  Nick Porch: *nick.porch@arts.monash.edu.au*;
- **Macrobotany**
  Tara Lewis: *tmlew2@student.monash.edu*; and,
- **GIS co-ordination**
  Sophie Bickford: *Sophie.Bickford@csiro.au*

Please contact the relevant person if you have information to contribute.

The OZPACS spatial database will initially be accessed through a password protected area of the EFN and AQUA websites, with further links and open-access to follow once completed. OZPACS already has a password protected area of the EFN website (*http://nesuab.ees.adelaide.edu.au*) available for communication among working group members.

THE FUTURE

OZPACS has several meetings planned, and the next meeting in early 2007 will focus on the application of recent palaeoenvironmental reconstruction to natural resource management and on understanding the cultural component of recent environmental change, including perspectives from archaeologists and historians. If you would like to become an OZPACS member, contribute to the debate, or simply be kept up-to-date with progress, please contact Scott Mooney: *s.mooney@unsw.edu.au*.

OZPACS CONVENORS

Dr Peter Gell, University of Adelaide (*in absentia*)
Dr Scott Mooney, University of New South Wales
Dr Sophie Bickford, CSIRO-Canberra
Dr Tim Denham, Monash University

Workshop Participants (pictured above, left to right): Gary Hancock, Chris White, Scott Mooney, Tim Denham, Cameron Barr, Quan Hua, Ian Thomas, Sophie Bickford, Michael Fletcher, Kathryn Taffs, Matiu Prebble, Stephen Gale, Nick Porch, Allan Chivas, Dan Faith.

In attendance but not in photo: Ralph Ogden, Michael Reid, Simon Haberle, Adriana Garcia, Tara Lewis, Angus MacGregor, Tim Barrows, Christine Kenyon, Pia Atahan

XVII INQUA Congress 2007

Cairns Convention Centre

Cairns, Australia 28 July–3 August 2007

The seventeenth INQUA (International Union for Quaternary Research) Congress will be held in Cairns, Australia from the 28th July to the 3rd August 2007. This will represent a particularly important event to showcase Australasian Quaternary science, especially as it represents the first such meeting in our region since the ninth Congress held in Christchurch, New Zealand in 1973. Every four years the international Quaternary community gathers for the INQUA Congress. This is the largest gathering of its kind for researchers with interests in Quaternary science, and in keeping with previous congresses, next year's meeting will appeal to researchers from a diverse range of subject areas such as palaeoclimatology, archaeology and palaeoanthropology, glaciology and palaeoenvironmental reconstruction.

Despite current controversies, the Quaternary is increasingly being recognized as the past 2.6 Ma of Earth history. The Quaternary is an interval characterized by dramatic changes in global climate with repeated transitions from warm interglaciations to cold glaciations. One of the characteristics of Quaternary science is that it is an inherently multidisciplinary endeavour and so INQUA congresses are particularly exciting for the range and diversity of topics presented.

Program Outline Although the program is being continuously updated, it is planned to include about six major plenary sessions in the main auditorium in the Cairns Convention Centre together with a series of keynote addresses linked to topical symposia. There will be up to eight parallel sessions of symposia and oral sessions. Except for plenary and keynote addresses, oral presentations will be 15 minutes in duration. Poster presentations will be displayed in two 3-day blocks separated by the mid-conference excursions. At present, the program outline allows for about 800 oral papers, excluding keynote and plenary presentations.

Plenary Sessions and Keynote presentations Six major plenary events (one per day in the main auditorium) are proposed; each will have 2–3 principal speakers addressing a theme of global significance. One of the plenary events will be held to honour the late Sir Nicholas Shackleton and will examine "Innovations in Quaternary Science". Symposia and sessions have the option of including a Keynote address.

Abstracts, submission and publication All abstracts should be submitted by the 31st January 2007. Submission will be electronic via the INQUA 2007 website. Abstracts will be published as an issue of Quaternary International and will be distributed to delegates at the Congress.

Program Themes The list of congress themes is growing and people are encouraged to contact members of the organizing committee with suggestions for symposia. Some of the topics proposed thus far include:

- Environmental catastrophes and their high-resolution records in sedimentary archives
- Trends in Quaternary research
- Quaternary continental events in the marine record
- Land-ocean correlation of the southern hemisphere long Quaternary records on orbital and sub-orbital timescales (INQUA PALCOM project)
- Advances in Quaternary geochronology
- Aeolian dust as a recorder of environmental change
- Fire: past, present and future
- Quaternary climate change in drylands
- Decoupling eustasy, isostasy, neotectonics and ice-equivalent sea level
- Fluvial palaeohydrology
- Earth system models and past global changes

Additional topics are listed on the INQUA 2007 website.

Travel Support Limited funds are available to assist young scientists and students to attend the Congress. INQUA will preferentially support attendees from developing countries and Eastern Europe, and AINSE (Australian Institute of Nuclear Science and Engineering) and AQUA will be able to assist some Australian and New Zealand postgraduate students.

Fieldtrips Several pre- and post-Congress field trips will be held in Australia, New Zealand and Papua New Guinea, catering for a diverse range of research interests. Only limited places are available and further details will be regularly updated on the Congress website. Participants are encouraged to contact the field trip leaders for further information.

Enquiries All enquiries should be directed to the Congress email address: *inqua2007@icms.com.au*
XVII INQUA Congress 2007, ICMS Pty Ltd, GPO Box 2200, Canberra, ACT 2601, Australia
Tel. (02) 6257 3299, Fax. (02) 6257 3256

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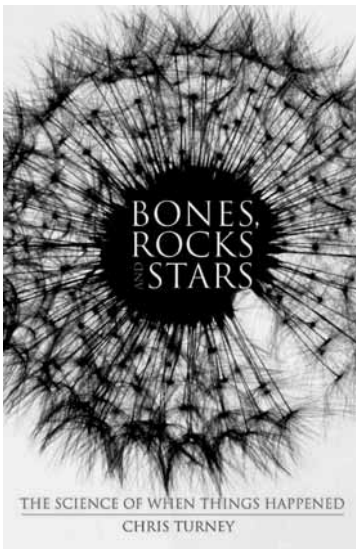

Chris Turney
Bones, Rocaks and Stars:
The science of when things happened
Palgrave/Macmillan, hardback,
AUD$49.95, ISBN 1403985995

This book gives a whirlwind tour through many of the popular numerical dating techniques, including radiocarbon, luminescence, potassium-argon, argon-argon, fission track, electron spin resonance, uranium-series, uranium-lead, amino acid racemization and dendrochronology, exuberantly written for non-specialists by British geologist Chris Turney, currently at the University of Wollongong's School of Earth and Environmental Sciences. The author points out some of the difficulties inherent in fixing historical events from textual sources based on different calendars, the value and limitations of archaeological typology, and along the way takes a few solid swipes at the beliefs espoused in creationist dogma. Turney uses well-known Old World examples—the legendary King Arthur, the Shroud of Turin, Egyptian pyramids and the Santorini volcanic eruption—to introduce radioactivity, measurement uncertainty and the calibration of radiocarbon results using precise tree-ring records, nicely illustrating different attempts to solve chronological problems at the interface between history and prehistory.

These examples set the scene for lively excursions through sea level and climate changes, Milankovitch's orbital calculations, Quaternary glacial-interglacial cycles, stable isotope records in deep-sea cores, ice cores and corals, and the evolutionary significance of Australopithecines, *Homo erectus* and the Neanderthals. The use in geology and archaeology of proxies for environmental conditions, such as pollen and charcoal particle counting, and dating methods not based on radioactivity (e.g. tephrochronology and amino acid racemization) are also explored. We get the flavour of some of Turney's own work using ABOX radiocarbon methods, frequently in tandem with luminescence analysis, on Australian and Indonesian sites relevant to the colonisation of Australia, megafauna extinction, and the diminutive 'Hobbits' on Flores. A tad more detail in these current research chapters might have explained better why these questions, such as problems with finding and isolating suitable sample materials for the various methods, continue to tax the ingenuity of geochronologists. Much earlier times are represented by pre-radioactivity attempts to estimate an age for the Earth, rounded out with extra-terrestrial materials and extinction of the dinosaurs.

One reviewer's post on the Pharyngula science blog run by P. Z. Myers reads: "I initially misread the title as 'Bones and Rock Stars.' When I saw the first line 'How do we know how old things are?' I immediately thought of the Rolling Stones. What dating method would be appropriate for them? Radiocarbon? Counting rings?" That he obviously continued reading speaks volumes for this book.

Much of the material presented by Turney about dating objects and events may be found in other popular science books, and in many more specialised accounts of some topics, but there is nothing quite like his high-spirited take on all of this. *Bones, Rocks and Stars* is well researched and covers a lot of ground in a splendidly personal style, which is appropriate for what I assume to be his target readership – late high school to early undergraduate non-science students, and interested laypersons. And there could be a problem with that: the northern hemisphere list price is £16.99 or US$24.95, but Australians are expected to pay $49.95. Potential buyers might balk at this price, and may well opt for the current Amazon.com offer of US$15.72 instead. This is not Chris Turney's fault; his excellent adventures in telling the time would almost certainly (>99% Confidence Interval) sell a lot more copies for Palgrave/Macmillan as a $25 paperback. Highly recommended for the target audience, and particularly science-challenged archaeologists.

– Richard Gillespie

Reconstructing El Niño-Southern Oscillation: Evidence from Tree-ring, Coral, Ice and Documentary Palaeoarchives, A.D. 1525–2002.

JOËLLE GERGIS (PhD)
School of Biological, Earth & Environmental Sciences, University of New South Wales, Sydney, New South Wales 2052, Australia.

El Niño-Southern Oscillation (ENSO) is the most important coupled ocean-atmospheric phenomenon to cause global climate variability on inter-annual time scales. Efforts to understand recent, apparently anomalous ENSO behaviour are hampered by the lack of long, high-quality climate records. While instrumental data generally covers the past 150 years, record length is insufficient for the assessment of past changes in the frequency, magnitude, and duration of ENSO. Here, multiproxy networks of high-resolution tree-ring, coral, ice and documentary records derived from eastern and western Pacific ENSO 'centres of action' are analysed (A.D. 1525–2002). Considerable improvements in ENSO reconstruction are achieved from expanding the use of records from the western Pacific. In particular, ~500 years of a continuous 3,722 year ENSO sensitive tree-ring record from New Zealand is introduced.

Although extreme ENSO events are seen throughout a 478-year discrete event analysis, 43% of extreme, 20% of very strong and 28% of all protracted ENSO events occur within the 20th century. Principal component analysis was used to extend instrumental records of the Southern Oscillation Index (SOI) Niño 3.4 Sea Surface Temperature (Niño 3.4 SST) and a newly developed coupled ocean-atmospheric ENSO index (CEI) by 347 years. Significantly, of the three indices reconstructed here, CEI reconstructions were largely found to be the best predictors of ENSO. The results suggest that ENSO may be more effectively characterised using a coupled ocean-atmosphere index, particularly for December-May periods.

Compared to the pre-instrumental period, the late 19th and early 20th centuries indicate a clear trend toward increased ENSO variability over the past 150 years. Significantly, spectral analysis of reconstructed indices reveals a marked change in the frequency and intensity of ENSO beginning ~A.D. 1850, coinciding with the end of the Little Ice Age and the boom in global industrialisation. This suggests that ENSO may operate differently under natural (pre-industrial) and anthropogenically influenced background states. This study asserts that recent ENSO variability appears anomalous in the context of the past five centuries. Given the considerable socio-economic impacts of ENSO events, future investigation into the implications an increasingly anthropogenically-warmed world may have on ENSO is vital.

Climate controls on trace element variability in cave drip waters and calcite: A modern study from two karst systems in southeastern Australia

JANECE MCDONALD (PhD)
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The results from a three-year geochemical study of two karst areas (Wombeyan Caves and Cliefden Caves) in southeastern Australia are presented. The principal aim was to explore the relationships between rainfall, drip water chemistry and speleothem geochemistry, with a view to improving ways for interpreting trace element (TE) variations in Quaternary fossil speleothems. A "total system" approach was adopted whereby a speleothem's geochemistry was viewed as the end product of a series of inputs and processes, each potentially linked to climate, particularly rainfall. The geochemistry of meteoric precipitation (rainfall), particulates (dust) and cave drip waters was analysed (Ca, Mg, Sr, Ba, K, Na and $\partial^{18}O$), whilst the potential soil and bedrock contribution to the cave drip waters was quantified via laboratory leaching experiments. Calcite deposited on artificial substrata was analysed for Mg, Sr, Ba, K, Na, P, U, $\partial^{18}O$ and $\partial^{13}C$. Field partition coefficients for Mg, Sr and Ba were calculated. Each drip was monitored for discharge and at six sites discharge was continuously measured.

The sites (240 km apart) showed a distinct hydrogeochemical response to climate due to dissimilar lithologies, composition of atmospheric inputs (rainfall and dust) and soils. Leaching experiments showed that soil potentially plays a crucial role in the evolution of the drip water geochemistry (and ultimately calcite) and advised the need to consider its relative contributions under differing flow conditions. Several drips displayed similar responses to recharge, but their respective hydrographs showed differing detail, reflecting the degree of interconnectivity, extent of the recharge zone and the change in the fracture architecture with increasing depth. The hydrograph is shown to be a powerful tool in the discrimination of drip behaviour. The extent of vadose-zone storage is shown to be pivotal to the recharge-discharge behaviour at recharge-sensitive drips.

The strong 2002/2003 El Niño episode, followed by further drought in 2004, allowed for the quantification of interannual-subannual aridity on cave drip waters and speleothem calcite geochemistry. At near-surface sites, drip discharge fell to base flow during these periods and was coupled with declines in drip Ca and co-varying increases in drip Mg/Ca and Sr/Ca. Prior calcite precipitation (PCP) was proven both qualitatively and quantitatively at shallow sites. Theoretically predicted calcite Mg/Ca and Sr/Ca displayed a marked increase through, and just beyond, periods of greatest moisture deficit. Actual calcite precipitated from these waters preserves the co-varying pattern of Mg/Ca and Sr/Ca but does not reproduce the same level of detail as predicted from experimentally-derived partition coefficients. This was attributed to the variable calcite precipitation rate which meant that the collected calcite traversed two or more hydroclimatological periods.

Sodium is shown to be an unreliable palaeohydrological proxy; phosphorus is linked to soil water residence times; drip water TE supply and inter-relationships with $?^{18}O$ and $?^{13}C$ are shown to be strongly associated with bedrock depth (open- or closed-system conditions)

A Holocene History of Vegetation Change in the Western Torres Strait Region, Queensland, Australia.

CASSANDRA ROWE (PhD)
School of Geography and Environmental Science, Monash University

Torres Strait is a largely submerged continental shelf separating Cape York, Australia, from New Guinea. The region spans approximately 150km north-to-south and contains more than 100 islands, coral reefs and sand cays, representing the largest tropical archipelago adjacent to the Australian mainland. The 1970s marked the start of sustained archaeological research in the Torres Strait islands. That the islands are home to indigenous populations largely of Melanesian descent, demonstrating

levels of marine exploitation, canoe technology, inter-island trade relationships and use of agriculture of a kind and degree not seen elsewhere in Australia, has been the focus of much archaeological curiosity. The subsequent perception of Torres Strait as a cultural and geographical boundary between the New Guinean and Australian landmasses, the so called 'bridge and barrier' theme, has overwhelmed research across the region, yet this work has never integrated detailed palaeobiogeographical perspectives.

This thesis presents results of the first systematic palaeobiogeographical investigation undertaken in Torres Strait. Palynological investigations centered on the islands of Mua, Badu and Zurath are aimed at the reconstruction of vegetation histories in mangrove, swamp, rainforest and sclerophyll environments. Targeting the Holocene history of each dominant island vegetation community allows for more specific research goals to be addressed: a comparison of vegetation change at local and regional scales; an examination of human impacts on island ecosystems; and discussion on the implic-ations of environmental change for Torres Strait archaeological records. As a consequence of poor preservation and a lack of depositional sites, palaeoecological records have been limited in the seasonal Australian tropics. Knowledge relating to late Quaternary environments in northern Australia is therefore scarce. Palaeoenvironmental investigations of northern Australia's Torres Strait are a means of partially improving this situation.

Eleven sediment cores from a series of inland and near-coastal swamps, as well as archaeological deposits, are investigated in this thesis, using fossil pollen and spore counts, charcoal analysis, stratigraphic properties and radiocarbon dating. The interpretation of fossil pollen assemblages is facilitated by the study of modern pollen dispersal and preservation, through the analysis of, and statistical comparison with, surface sediment and moss polster samples. The results show certain pollen types, or pollen type combinations, are useful in distinguishing between current vegetation communities, but that prior to 3500–3000 yr BP, vegetation and plant taxa associations in Torres Strait were without strong parallel in modern vegetation patterns. Methodologically, the inclusion of archaeological deposits allows for the close integration of palaeoecological and archaeological research, merging pollen analysis and artifact studies. With a strong correspondence evident in the late Holocene between the presence of artifact remains, high charcoal particle concentrations and a decline in forest cover, such information is useful in helping to interpret non-archaeological swamp pollen and charcoal sequences, in terms of climatic change and human activity.

Reconstruction of island coastal palaeoenvironments suggests that between 7000 yr BP and 6000 yr BP there was relatively abrupt change from non-mangrove to mangrove communities along the coast, which did not feature a succession of neatly zoned mangrove forms. Extensive stable mangrove communities dominated between about 6000-3000 yr BP, consistent with pollen records from mainland northern Australia. With a decline in mangrove dominance beginning about 3000 yr BP, near-shore island vegetation succession involved lower-tidal mangrove, upper-tidal mangrove, saltmarsh, and freshwater swamp community types with variations according to the geomorphological setting local to the core site. It is suggested that changes in Torres Strait coastal vegetation, and especially mangroves, accompanied marine transgression before a stabilisation of sea levels and the initiation of dominant onshore catchment processes, reflecting both natural and anthropogenic activity.

Inland of the coastal zone, and by 8000 yr BP, Myrtaceae forest colonised Mua and Badu, maintaining broad distributions until a change in vegetation structure beginning 3500-3000 yr BP. A decline in tree density in western Torres Strait resulted in dominance by open woodland from this time. Island rainforest communities also changed in the late Holocene. By 7000 yr BP rainforest was locally dominant, only to decline in distribution and become marginal to sclerophyll vegetation communities after 3000 yr BP. Island environments were more frequently burned after 3500–3000 yr BP, an increase in the occurrence of fire possibly contributing to forest demise. At about the same time, or slightly later, sediment erosion, transport and deposition, together with the accumulation of organic matter in low-lying areas, facilitated swamp expansion. Reconstruction of the vegetation away from the mangroves suggests that between 7000 yr BP and 3000 yr BP wetter conditions than those of today prevailed in Torres Strait. Vegetation and landscape changes that took place after 3500–3000 yr BP can be attributed to deterioration in such a climate, incorporating increased interannual and seasonal variability. However, there is evidence also of increased human impacts after 3500 to 2500 yr BP, coincident with the onset of island occupation and greater settlement permanency and landscape investment respectively.

The Torres Strait is a unique, diverse component of northern Australia, subject to climatic change and incorporating significant vegetation change through the course of the Holocene. In this thesis, palynological records from Mua, Badu and Zurath provide more than a simple catalogue of environmental change as background information or archaeological context; they are able to confirm palaeoenvironmental reconstructions from mainland northern Australia, but also demonstrate a degree of variation, suggesting regional differences. These variations appear to be a reflection of local-scale topography and island settlement history. The need for more pollen work to be instigated in the seasonal tropics of northern Australia is apparent.

The Dynamics of the Leeuwin Current during the Quaternary

MICHELLE SPOONER (PhD)
Department of Earth and Marine Sciences, Australian National University

This thesis details the dynamics of the Leeuwin Current, specifically trying to determine the nature and timing of oceanic events that prevailed off the western and southern coastlines of Australia during the last 550,000 yrs. The Leeuwin Current is an anomalous eastern boundary current transporting warm, low salinity water formed within the Indonesian Throughflow. The influence of this current extends from North West Cape in Western Australia to (occasionally) the southern tip of Tasmania. The strength of the Leeuwin Current is seasonal and has a temporal variability due to variation in the alongshore pressure gradient and prevailing equatorward winds. It is believed the Leeuwin Current operated differently during glacial and interglacial periods due to an alteration in the forcing mechanisms; this has implication for the regional oceanography and climate.

Data were obtained from marine cores located below the present-day pathway of the Leeuwin Current, core MD61 located on the shelf edge offshore Western Australia (113°28.63 ´E, 22°04.92 ´S) and

core MD2607 (13724.39 ´E, 36°57.64 ´S) located on the upper continental slope offshore South Australia. An additional core, located offshore Sumatra (BAR9403, 5°49.20 ´S 103°61.90 ´E) was also examined to understand possible forcing mechanisms that may alter the past dynamics of the Leeuwin Current. Planktonic foraminifera assemblages, the $\partial^{18}O$ and $\partial^{13}C$ of near-surface dwelling foraminifera, and sea-surface temperature estimates were used to reconstruct the vertical structure of the water column through the past ~550, 000 yrs. The forcing mechanisms behind the strength of the Leeuwin Current can also be inferred from these data.

These findings indicate a weak Leeuwin Current was present on the western coastline of Australia during glacial periods but it did not reach the southern core site during Marine Isotope Stage 6. However, there is some evidence of the Leeuwin Current reaching the southern core site during the last glacial maximum due to the presence of transitional water.

There was a greater influence of South Indian Central Water at the site of MD61 offshore Western Australia due to the northward migration of the Indonesian Throughflow Water /South Indian Central Water frontal system by 3–4° which also resulted in a 6–9°C decrease in SST, a thickening of the mixed layer and the dominance of transitional species during glacial periods. The dominance of South Indian Central Water also suggests that the West Australian Current, which presently sits below the Leeuwin Current, was strengthened during the glacial periods and aided in weakening the Leeuwin Current. At core MD2607, offshore South Australia, there was an increase in Subantarctic Mode Water and upwelling of nutrient-rich water due to the reduction/absence of the Leeuwin Current during glacial periods.

There is an upwelling signal in core BAR 9403 (offshore Sumatra), at 14 000 yrs BP that disrupts the warm stratified water column, which was a feature between MIS 3 to present. The upwelling offshore Sumatra is timed to a regional pattern of an intensified Australasian Monsoon. Findings within MD61 and MD2607 also suggest a stronger Leeuwin Current at ~14,000 yrs BP; it was also stronger during Marine Isotope Stage 5, 7, and 11 due to a thicker component of Indon-esian Throughflow Water sourced from the Warm Pool, located in the equatorial Indian-Pacific region. This may also suggest an intensified monsoonal system during interglacial periods. Conversely, it appears that the Australasian Monsoon was generally weakened during the glacial periods which aided in reducing the flow of the Leeuwin Current and strengthening the West Australian Current.

Late Quaternary Rivers and Lakes of the Cadell Tilt Block Region, Murray Basin, Southeastern Australia

TIM STONE (PhD)
School of Earth Sciences
The University of Melbourne

A record of climatic, hydrological and tectonic change spanning the last glacial cycle (~130,000 years) has been obtained from alluvial, aeolian and lacustrine sequences in the Cadell Tilt Block region of the central Murray Basin. Optically stimulated luminescence (OSL) is the principal method of chronological control, with a total of 50 new luminescence ages. Two AMS radiocarbon (^{14}C) ages are supplementary. Soils are used for relative dating of landforms beyond the range of OSL and ^{14}C. The result is the largest corpus of late Quaternary ages ever produced for the region.

The chronology of the Lake Tyrrell lunette sequence has been revised from previously published interpretations. Beach sediments ~13.5 m above the present lake floor were deposited by Lake Chillingollah, a marine oxygen isotope stage (MIS) 5 (~130,000-75,000 years ago) megalake. The megalake dried because of decreasing winter rainfall and fragmented into a groundwater discharge system. A silty clay dune deflated from the Lake Tyrrell floor ~27,000 years ago ended a long period of pedogenesis and buried evidence for Aboriginal visits to the area.

The earliest evidence for aridification along the Murray River is an episode of riverine source-bordering dune formation in early MIS 4 (~72,000 years ago). The event is a minimum age for the initiation of construction of the Barmah Fan, which accreted in response to uplift of the Cadell Tilt Block. Fan sedimentation on the foot wall close to the fault scarp appears to have accelerated between 65,000 and 45,000 years ago. The Green Gully palaeochannel on the uplifted block was abandoned by the Murray River soon after this period, which culminated in an episode of riverine source-bordering dune formation ~40,000 years ago.

The Goulburn River was not defeated by uplift. An older prior stream on the uplifted block, with undatable strong red-brown earth soil profiles along its margins, is not a course of the Goulburn. Instead, the Goulburn River was deflec-ted to the southwest where it developed the Tallygaroopna meander belt ridge. This course had been deflected by ~65,000 years ago. Vertical aggradation of the ancestral Goulburn continued until ~23,000 years ago. Riverine source-bordering dunes were beginning to form again when a clay plug filled the palaeo-channel.

The Tallygaroopna meander belt ridge is visible beneath the floor of Lake Kanyapella on LIDAR DEM imagery. Downstream it follows the course of Gunbower Creek. Lake Kanyapella is not fault-dammed or fault-controlled because it post-dates formation of the ridge. The lake formed ~34,000 years ago and was sustained by flows from the Tallyga-roopna palaeochannel for ~10,000 years. A model of lake formation is proposed based on vertical bedload aggradation. That is, the lake emerged because the Goulburn River had fully-aggraded and could no longer channel its flood flows. This long-term ponding may be of wider palaeohydrological significance. Riverine source-bordering dunes form only at the end of the lacustral period.

The Goulburn River avulsed from the meander belt ridge at the end of the Last Glacial Maximum (~18,000 years ago). The Kotupna palaeochannel was rapidly entrenched and back-filled, with riverine source-bordering dunes emplaced along its course in a geological instant. The harsh climate of the LGM was adapted to by the Kow Swamp people who developed robust physical morphologies in response to the cold conditions. Gracilization of the population is related to post-glacial climatic amelioration, which increased gene flow. Robust humans are rare after the LGM.

Palaeochannel morphology is not climatically-controlled. Kotupna-type bars were deposited along the Bullatale Creek course of the Murray River in the Holocene, without any concomitant source-bordering dune formation. The Barmah Choke reach of the Murray River is relatively straight because it is a modern avulsion, not an inert Holocene river course. This avulsion happened only ~550 years ago, effectively shutting down the depositional system that constructed the massive Wakool Fan. This event ended a 75,000 year long avulsion sequence.

NEWS

Brent Alloway recently accepted a job in Quito, working in SE Ecuador in the headwaters of the Amazon (on the Ecuador-Peru border). He has resigned from his role in NZ INTIMATE and from his post as NZ Vice President of AQUA.

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Mr Ashley Natt, Environmental Biology, University of Adelaide has been awarded a three year AINSE postgraduate research award for his project "Scales of variability: El Niño, human impact and Greater Flamingo populations in internationally significant Galapagos wetlands". Ash will be using diatom analysis and stable C, N and O isotopes to trace climate variability, human impact and possibly fluctuations in flamingo populations in the Galapagos Islands. Ash will be supervised by John Tibby (UofA), Simon Haberle (ANU) and Peter Gell (UofA).

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The AQUA travel prize for 2006 was awarded to Simon Connor from Melbourne University. All entries were of a very high standard. Simon was invited to present his work at the "Plant Macrofossil Records from Northern Eurasia Workshop", held at Dartington Hall, Devon, UK, from 28th May to 1st June 2006).

UPCOMING EVENTS

MedCLIVAR 1st workshop: Carmona, Seville, Spain 9–11 Nov. 2006 International Workshop on Reconstruction of Past Mediterranean Climate: Unexplored Sources of High-Resolution Data in Historic Time. More information: *http://www.medclivar.eu/workshop_1.html*

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5th **Southern Connection Conference, Adelaide, South Australia** 21–25 January 2007, The University of Adelaide *www.ees.adelaide.edu.au/events/Southern_Connections/* contact: Maria Lekis: *maria.lekis@adelaide.edu.au*

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Mungo Festival – Legacy of an Ice Age A major conference involving Natural & Cultural Themes, Mungo Lodge, Mungo, September 7–9 2006. *www.mungofestival.com.au*
Jim Bowler: *jbowler@unimelb.edu.au*
Matt Cupper: *cupper@unimelb.edu.au*

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First meeting of the Rivers Research Group (part of the Australia and New Zealand Geomorphology Group) Canberra and Kioloa, first Week in February 2007.
This meeting will be an opportunity for those involved in geomorphological river research to get together, share our latest research findings and also for post-grad students, learn a few tricks of the trade. More details will be available on the ANZGG website *http://www.anzgg.org* or contact Paul Rustomji 02 6246 5810, *paul.rustomji@csiro.au* for more details.

RECENT PUBLICATIONS

- Claessens, L., Lowe, D.J., Hayward, B.W., Schoorl, J.M. and Veldkamp, A. 2006. Reconstructing high-magnitude/low-frequency landslide events based on soil redistribution modelling and a Late-Holocene sediment record from New Zealand. *Geomorphology*, 74, 29–49.
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- Gergis, J. and Fowler, A. 2006. How unusual was late Twentieth Century El Niño-Southern Oscillation (ENSO)? Assessing evidence from tree-ring, coral, ice and documentary archives, A.D. 1525–2002. *Advances in Geoscience*, 6: 173–179.
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- Hua, Q., Woodroffe, C.D. Smithers, S.D. Barbetti, M. and Fink, D. 2005. Radiocarbon in corals from the Cocos (Keeling) Islands and implications for Indian Ocean circulation, *Geophysical Research Letters*, 32, L21602, doi: 10.1029/2005GLL023882.
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- McDonald, J. and Drysdale, R. (submitted). Hydrology of cave drip waters at varying bedrock depths from a karst system in southeastern Australia. *Hydrological Processes*.
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- Rustomji, P., Olley, J. and Chappell, J. 2006. Holocene valley aggradation driven by river mouth progradation: examples from Australia. *Earth Surface Processes and Landforms*.
- Rutherfurd, I.D. and Kenyon C.E. 2005. Geomorphology of the Barmah-Millewa Forest. *Proceedings of the Royal Society of Victoria*, 117: 23–39.
- Stone, T. (in press). Last glacial cycle hydrological change at Lake Tyrrell, southeast Australia. *Quaternary Research*.
- Stone, T. (in press). The late-Holocene origin of the modern Murray River course, southeastern Australia. *The Holocene*.
- Webb, S., Cupper, M.L. and Robins, R. 2006. Pleistocene human footprints from the Willandra Lakes, southeastern Australia. *Journal of Human Evolution*, 50: 405–413.

Quaternary AUSTRALASIA

Quaternary Australasia publishes news, commentary, notices of upcoming events, travel, conference and research reports, post-graduate thesis abstracts and peer-reviewed research papers of interest to the Australasian Quaternary research community. Cartoons, sardonic memoirs, images of mystery fossils and amusing occupational health and safety breaches also welcome.

The Australasian Quaternary Association (AQUA) is an informal group of people interested in the manifold phenomena of the Quaternary Period. It seeks to encourage research by younger workers in particular, to promote scientific communication between Australia and New Zealand, and to inform members of current research and publications. It holds biennial meetings and publishes the journal *Quaternary Australasia* twice a year.

The annual subscription is AUD$35, or AUD$25 for students, unemployed or retired persons. To apply for membership, please contact Janelle Stevenson (address below). Members joining after September gain membership for the following year. Existing members will be sent a reminder in December.

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