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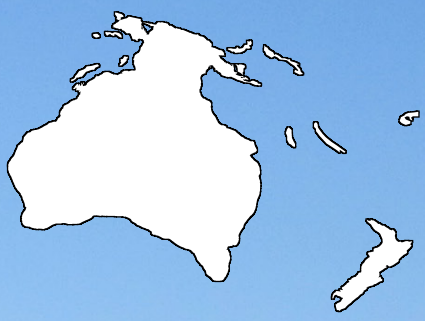
Quaternary AUSTRALASIA



Timing of human occupation of the South Australian arid zone

Spotlight on Lake Tekapo: AQUA 2012

Best of British: UK QRA 2012

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COVER: The resplendent Lake Tekapo (Photo: H. Bostock)

BELOW: David Barrell discussing the glacial retreat of the Mueller and Hooker glaciers over the last 6000 years to a rather wet and cold group at the Mueller Glacier lookout (Photo: H. Bostock)

Editorial

Editorial

Dear Fellow Quaternarists,

Our first issue for 2012 signals a changing of the guard for Quaternary Australasia, and for AQUA in general. After two productive years as Co-editor, Jessica Reeves will be stepping down in order to take up new responsibilities within the AQUA executive committee. Jasmyn Lynch of University of Canberra will be joining the editorial team in her place. Thanks, Jessica, for your excellent teamwork over the past few years, and welcome, Jasmyn, to editorial responsibilities!

Quaternary Australasia looks inland this issue with a research article by Marjorie Sullivan and colleagues which integrates geomorphic and archaeological records in the Lake Eyre basin dunefields. This paper highlights the advantages of adopting an interdisciplinary approach to understanding landscape change, which provides environmental context for human occupation and dispersal through time.

February saw the AQUA biennial conference move across the Tasman Sea for the first time since 2004, where it was hosted with much aplomb on the shores of Lake Tekapo on the South Island of New Zealand. Reports by early career researchers in this issue attest that it was a most successful meeting, despite some inclement weather for the field trip. The next meeting will coincide with AQUA's 30th anniversary, and the plan is to revisit the association's roots and visit an iconic Quaternary site, Lake Mungo. More details can be found in the News section.

We also hear from Esmee Webb about the innovative research being undertaken in the UK by members of the Quaternary Research Association at their most recent meeting in the south of England; it's great to hear of vibrant research communities elsewhere in the world. In addition, the recently published tribute volume to Peter Kershaw (in commemoration of his recent retirement) is reviewed towards the end of this issue.

This is also the last issue of QA that will see the fine graphic skills of our designer, Anthony Bright. He has been making QA the classy looking publication that it is since 2007. We thank him for his fine work and wish him well.

Finally, we pay tribute to Jim Peterson, one of the more innovative geomorphologists in the Australasian region, who recently passed away.

Yours Quaternarily

Kathryn Fitzsimmons and Jessica Reeves (and incoming Editor, Jasmyn Lynch)
Co-editors

President's Pen

President's Pen

Dr Chris Stringer from the Natural History Museum in London spoke at a meeting of the Canterbury Branch of the Royal Society in February, on his research into the history of human occupation of the British Isles. He is the director of the Ancient Human Occupation of Britain (AHOB) project. As I looked out over the audience in one of the auditoriums (he filled two), the 'sea of grey', typical of Royal Society meetings, was broken with blonde, brunette, black and even purple. The theme of the talk, our ancestry, clearly resonates across society, and probably taps the same vein of interest as genealogy: From whom and from where did we come? I haven't pondered the sociology before, but I expect it's deeply rooted in a desire to understand our own behaviour – loves, fears, phobias, instincts – more deeply. I am no more than a popular-science book reader on this aspect of Quaternary research, but it appears profound to me to think that the climate variability characterising this time period was the context for the diaspora and the crucible for the development of our remarkable intelligence and culture. Yet this intelligence, which ponders its own origin and now delves ever closer to the origin of the Universe itself, is deeply flawed. I'm not sure if it's a morbid interest or a sense of moral duty to be informed that I read of the atrocities in Syria, where members of the same species torture and kill each other.

Thirty thousand years ago there were at least three species of humans in Eurasia: our species, Neanderthals and Denisovans. The recent mapping of an entire Denisovan genome from a finger bone from an individual whose remains lie in a cave in Russia shows that some groups of modern Homo sapiens share as much as 5% of Denisovan DNA. Clearly, our relations with other species of humans were sometimes sexual and perhaps even amorously nonviolent. The groups of modern humans with 5% Denisovan DNA include the Melanesians and Australian aboriginals. Where will this knowledge lead us – to greater understanding or to more prejudice? I read Dr Stringer's Homo Britannicus with fascination as he recounted how the 18th Century paleontologists in Britain grappled with the evidence of human artefacts amongst bones of exotic animals such as rhinoceros and hippopotamus while holding onto Biblical dogma. Contrivances involving ritual burials and multiple Noachian floods, which do not withstand Ockham's test, were offered as explanation. Extinction of small groups of humans during the Pleistocene may have come down as much to chance as to 'survival of the fittest'. I hope we come to see the Denisovan legacy as an enrichment of our human genome, potentially a treasure box from the past, rather than succumbing to a dogma of continuous evolutionary advancement.

This is my last President's Pen, as the election of new officers, at the May AGM, will take place before the next issue of QA. I have enjoyed my time serving the Australasian Quaternary Association as President. Thanks to my fellow exec members – it's been a pleasure working with you. A special thank-you is also due to David Barrell and Marcus Vandergoes who were part of the organising committee for the Biennial meeting in February. I wish the incoming executive officers well.

Peter Almond
AQUA President

AQUA Prize winners

Congratulations to all of the students who presented their work so professionally at the AQUA biennial meeting at Lake Tekapo in February. Again, the quality of student presentations on a wide variety of topics gave the judges a very difficult job. However, we are pleased to announce the following prize winners:

Prize winner, from left: Alice Doughty, Tom Brookman, Louise Moody, Stephanie Kermode

Louise Moody (1st prize - $500), Alice Doughty (2nd prize - $250, sponsored by Beta Analytical), Tom Brookman (GNS prize), Stephanie Kermode (Science Meets Parliament).

One of the key purposes of AQUA is to help students and early career researchers to develop both their oral and written presentation skills, in a collegiate environment. We hope the student participation in AQUA can continue to grow.

The new look AQUA website

As this issue goes to press, we also launch the updated AQUA website (www.aqua.org.au). In the short term, the new website will be built on the features of the old (past meetings, back issues of QA, AQUA projects) but we would like to expand this to include links to major Quaternary groups in the region and facilities and a searchable database of local expertise. Most importantly, we will now be able to process subscriptions, update membership details and pay for conference registration online! This is a big step forward for AQUA and will hopefully correct some of our recent problems – not to mention save some paper. If you have ideas for the website, contact Helen Bostock, our new IT editor: helen.bostock@niwa.co.nz. We would like to thank Tim Barrows, one of the longest standing members of the AQUA executive, for his work as IT editor, since the position was first created.

The new look AQUA Exec

After a straw poll of attendants at the AQUA meeting at Lake Tekapo, the new AQUA Executive was passed at the AQUA AGM, held at the University of Canberra on Monday 21st May. New chair holders (sitters?) include:

President – Jessica Reeves (Ballarat Uni)

Vice-President & IT Editor – Helen Bostock (NIWA)

Secretary – Duanne White (Canberra Uni)

QA Co-Editor – Jasmyn Lynch (Canberra Uni)

Steven Phipps will stay on as Treasurer, Kat Fitzsimmons as Co-Editor, Matt Cupper as Public Officer and Peter Almond as Past President. We have also revised the ex-officio roles to include: Patrick Moss (Science and Technology Australia), Henk Heijnis (ANSTO), Craig Sloss (National Quaternary Council) and Marcus Vandergoes (GNS). Although not part of the executive, we will be looking to identify local representatives at Quaternary-friendly universities to help spread the good word.

The next AQUA biennial meeting – Save the date!

We are excited to announce that the next AQUA biennial meeting will be held in Mildura, 7-11th July 2014. This will be almost 30 years after the inaugural meeting and will include a fieldtrip to Mungo and Public Lecture at the Grand Hotel to commemorate the event. We are hoping that many of the original attendees will be able to join us. Further details will be available in the December issue of QA, but save the date now! If you wish to be involved in the organisation of this event, please contact Jessica Reeves (j.reeves@ballarat.edu.au).

The Australian Archaeological Association Conference, 2012

The next AAA conference will be held in Wollongong, 10-13th December. The theme this year is "Science and Archeaology". The AAA Annual Conference is the major event in the professional calendar for archaeologists, including AAA members and non-members alike, along with Traditional Owners, cultural heritage managers and other related disciplines to get together, present and listen to papers and posters in order to find out about the latest archaeological discoveries, and catch up with colleagues they haven't seen for 12 months. AAA has approximately 1000 members and the Annual Conference typically attracts about 400 delegates from Australia and overseas. For more information see: www.conference.australianarchaeology.com.au.

PAGES Open Science and Young Scientists Meeting, 2013

After the terrific success of the inaugural PAGES Young Scientists Meeting (YSM) back in 2009, the time has come for the next round of early career palaeoclimatologists to strut their stuff. The next YSM is to be held in Goa, India 11-12th February, 2013. This immediately precedes the PAGES Open Science Meeting, 13-16th February. Abstract submission and registration have just opened. Go to: http://www.pages-osm.org/ysm or contact Steven Phipps (s.phipps@unsw.edu.au) for further details.

Caption competition

This photo was too good to not include, but we need help with the caption. The most creative and appropriate caption will entitle the winner to free membership for 2013. Send your entries to our secretary Duanne.White@canberra.edu.au. The winning caption will be announced in the next issue of QA.

Thanks, for the memories...

We would like to dedicate the next issue of QA to commemorating AQUA'a 30th anniversary. We will be asking some of our more senior Quaternarists for their recollections of former glory days. In the meantime, we would love to hear from all of you regarding anecdotes from past meetings, experiences with AQUA – fond or otherwise and particularly photos. We will be constructing a photoboard as part of our new look website and would like it as thoroughly populated as possible. Please send all material to our editorial team: Kat Fitzsimmons & Jasmyn Lynch on Editor@aqua.org.au.

OSL ages that inform late phases of dune formation and human occupation near Olympic Dam in northeastern South Australia

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Abstract

The Olympic Dam archaeological salvage program covers an area of 600 km² and contains more than 16,500 archaeological sites, most of which are open scatters of stone artefacts on linear sand dunes. Optically stimulated luminescence (OSL) dating offers an opportunity to date recent phases of dune movement and stability, and to provide a chronology for archaeological material on and in the sand bodies. Initial OSL ages from one large site in a deflation hollow on a dune are presented here. The dating was undertaken as part of a student project, and the results provide information on sand accumulation from about 12,000 years ago, with human occupation at the site occurring after that time.

Introduction and background

The ongoing Olympic Dam archaeological salvage program has been described by Hughes *et al.* (2011). It is a large research-oriented program following on from archaeological impact assessments at Olympic Dam in arid northeast South Australia (Figure 1).

In 1980 Hughes, Hiscock and colleagues commenced archaeological investigations for the Olympic Dam mining project (Figure 1). These continued as small area surveys, linear surveys for infrastructure corridors, and from 2007 to 2009 as a block survey of about 515 km² for the proposed expansion of the mine. In these investigations Hughes and Hiscock developed an environmentally-based predictive model (see Hughes *et al.* 2011) that used terrain pattern mapping based on a combination of landform types and underlying geology. Landform types were used to predict the location and frequency of occurrence of suitable 'campsites', sources of water and ease of movement across the landscape. Geology was used to predict the availability of different rock types for stone artefact manufacture. The model has proved to be robust, and has been used to underpin a survey strategy, and to locate, record and explain the distribution of more than 16,500 archaeological sites in the Olympic Dam area (Hughes *et al.* 2011). The sites were recorded using hand-held computers, and the survey records are consistent for the whole expansion area.

Almost all of the sites comprise surface scatters of flaked stone artefacts. Hearths, grindstones, ochre and manuports are found on some sites, and quarries and other procurement areas occur, but none of the sites recorded contain organic materials. Flaked stone artefacts form the basic materials for further analyses.

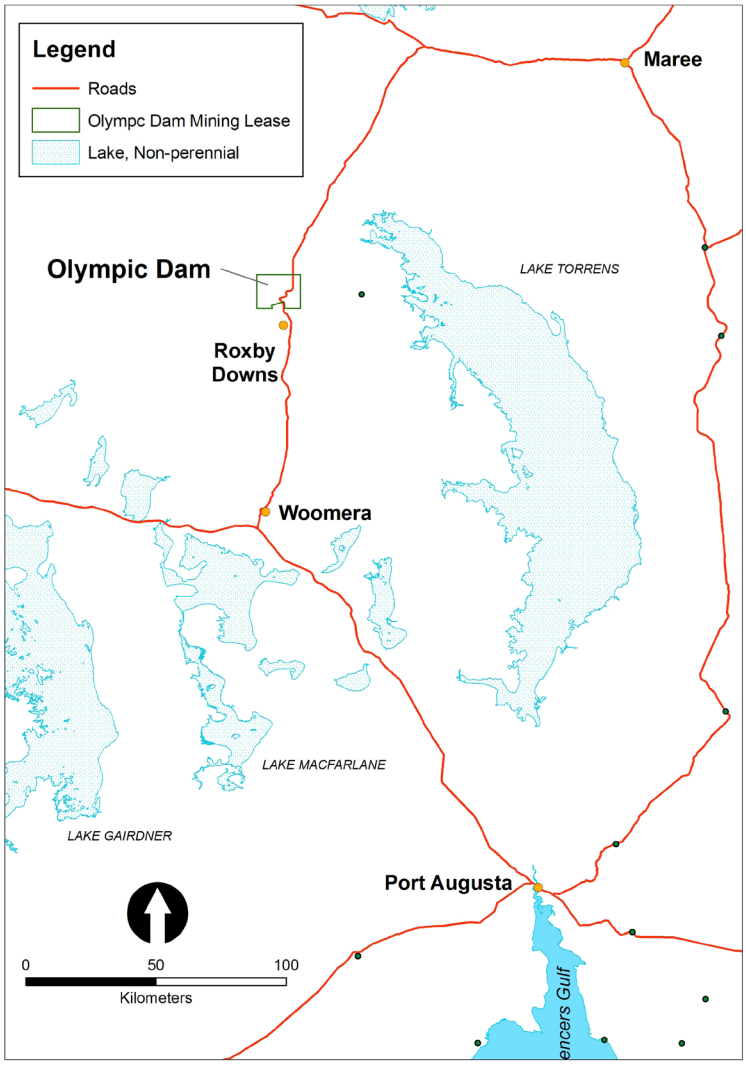


Figure 1. Location of the study area in South Australia. Map produced by BHP Billiton.

Following the survey phases, an archaeological salvage program commenced in mid-2010, and involved surface collection and excavation at 150 selected sites. In determining the number of sites and which sites warranted further study, several principles were employed as described in Hughes *et al.* (2011), which acknowledged that sites with high potential for scientific investigations are those with high chronological and spatial resolution.

Geoarchaeological questions at site ODO3A23 at Olympic Dam

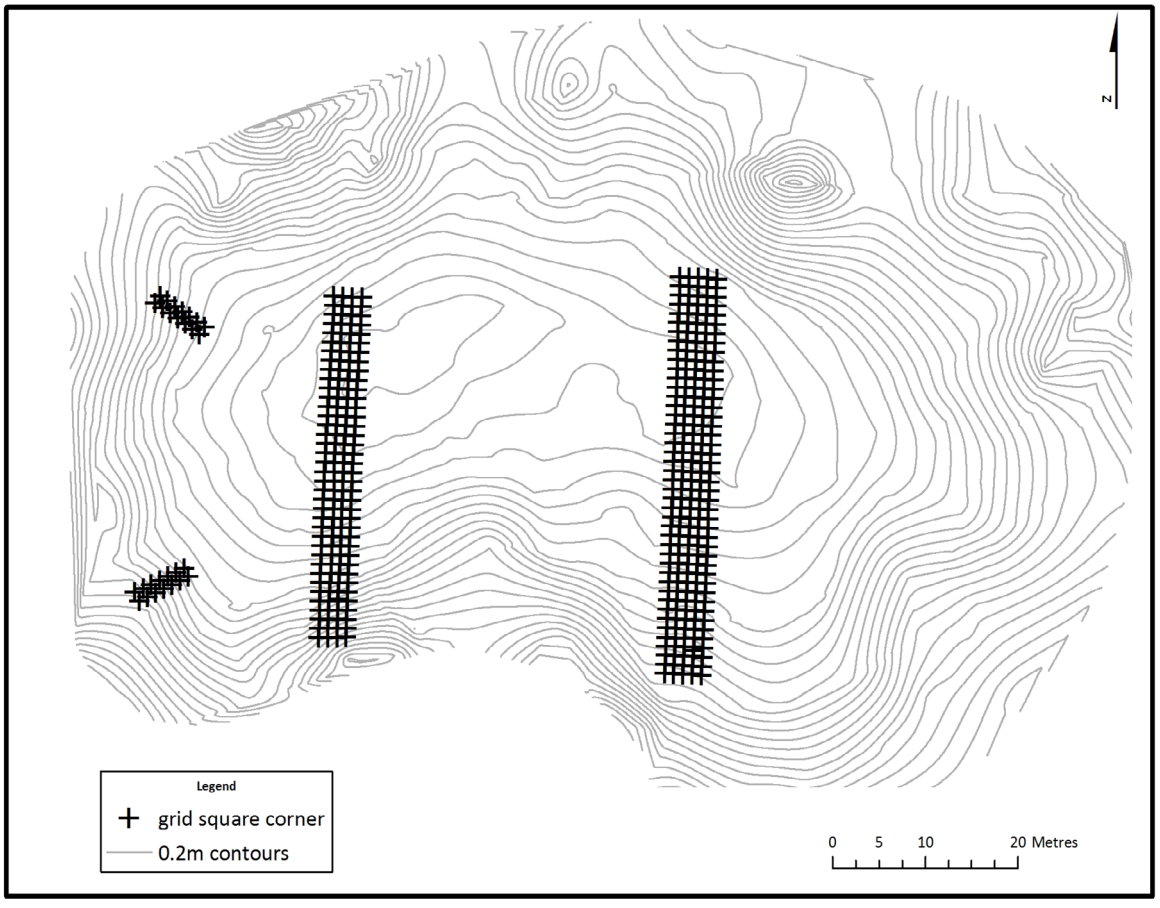
The salvage program based on the survey results and these principles commenced in July 2010. A University of Washington (UW) archaeological field school (under the direction of Dr Ben Marwick) was supported by the salvage program, and commenced in July 2010, very soon after the salvage program had begun. The field school students worked on some of the sites identified as having high priority, close to the mine and in areas that would be affected by the earliest stages of the proposed mine expansion. One site was a very large scatter of stone artefacts covering about 200 m² in a 2-5m deep wind-deflated depression (blowout) on a longitudinal sand dune immediately north of the existing mine - designated ODO3A23 (Figure 2).

This was a high priority site for salvage because of its location, and as it was considered to have potential to address some of the general questions posed for the Olympic Dam archaeological salvage program, including questions of occupational chronology:

- Did people who occupied the area in the past camp in existing blowouts which have retained their general form over long periods of time, or have the blowouts formed subsequently, with stone artefacts having being lowered as the deflation process occurred?
- Did an occupied blowout change its form after the main phase(s) of past occupation?
- Are there archaeological materials buried around the rims of blowouts? If so is their nature and content similar to the materials exposed in the blowout?
- Is it possible to date occupation of the blowout? Do any parts of the site show spatial or chronological integrity?
- Is it possible to date the age of the dune or the surface on which occupation occurred?

Sediment samples for OSL dating from ODO3A23 were analysed as a student project at the University of Washington Luminescence Dating Laboratory.

Figure 2. Site ODO3A23 showing the blowout, the two main artefact collection grids and the two excavated trenches on the western rim of the blowout. The OSL samples were taken from the southwestern wall of the northwestern-most square of the northern trench.



SAMPLE	UW2555	UW2556	UW2557	UW2558
Grains (n)	165	201	99	161
Burial Depth (mm)	395	495	645	845
D_E (Gy)	0.78 ± 0.19 *	5.85 ± 0.12	6.08 ± 0.18	5.94 ± 0.14
σ_b (%)	154±20	22±2	26±2	23±2
RADIOACTIVITY				
^{238}U (ppm)	0.55±0.05	0.56±0.05	0.33±0.04	0.22±0.04
^{232}Th (ppm)	0.88±0.32	0.88±0.33	1.42±0.40	1.67±0.48
^{40}K (%)	0.07±0.01	0.10±0.02	0.07±0.02	0.08±0.01
Dose Rates (Gy/ka)				
Alpha	0.16±0.02	0.18±0.02	0.14±0.02	0.14±0.02
Beta	0.19±0.02	0.14±0.02	0.19±0.03	0.20±0.02
Total D_R (Gy/ka)	0.46±0.05	0.48±0.05	0.44±0.05	0.46±0.05

Table 1. Radioactivity measurements, equivalent dose values and age determinations for site ODO3A23 samples. *The central age estimate of UW2555 was calculated from the 79 grains with a positive value. The others had a negative DE value indicating modern sand, and were not analysed.

OSL as a dating method for inorganic sediments in arid Australia

Dating of sediments using optically stimulated luminescence (OSL) has become important for studying earth surface processes (e.g., Rhodes 2011). Luminescence methods estimate the time since individual grains of quartz and feldspar were last exposed to sunlight. The dating range extends from very recent deposits to sediments deposited hundreds of thousands of years ago.

Mabbutt (1977) argued that the longitudinal dunefields and the basal imprints of the dunes in arid Australia are ancient - dating from the early Pleistocene. OSL dating has been used subsequently to investigate the chronology of dune formation and the possible human use of those environments (Murray-Wallace *et al.* 2002, Magee *at al.* 2004, Hesse *at al.* 2004, Hollands *et al.* 2006, Twidale *et al.* 2007, Lomax *et al.* 2007, Fitzsimmons *et al.* 2007), and luminescence ages have provided information about more recent phases of sand movement on and along the upper sections of these dunes.

The ages show a general association between dune building and aridity. Phases of dune-building activity have been identified from the Lake Eyre region and from the Strzelecki and Tirari Deserts during cold dry periods between about 50 ka and 35 ka, and again at the end of the last glacial maximum, from about 23 ka to a period between 12 and 14.5 ka (Fitzsimmons *et al.* 2007). Dune-building activity diminished in the Strzelecki and Tirari Deserts from the late Pleistocene into the early Holocene (Fitzsimmons *et al.* 2007) and the Tasman Sea dust record includes a peak of aeolian deposition ending at around the same time suggesting this was a widespread phenomenon (Hesse 1994). After about 12 ka, as the climate became wetter in the early Holocene, increased vegetation cover reduced aeolian activity (Hesse *et al.* 2004). There are suggestions from the dune records of the Tirari and Strzelecki Deserts (Fitzsimmons *et al.* 2007), from thermoluminescence ages from the Simpson Deserts (Nanson *et al.* 1992; 1995), and from pollen and OSL dates from the Darling Basin (Cupper 2005), that dune stability was associated with wetter conditions in the early to mid-Holocene, and dune remobilisation with drier conditions in the late Holocene after about 5 ka.

Lack of preserved organic material prevents the use of radiocarbon to date these sites, so other chronometric methods must be used. At Olympic Dam only relative ages for the region's surface archaeology have so far been suggested. The presence of characteristic artefact types such as numerous backed artefacts, pirri points and tula adzes, whose contexts have been well-dated in other Australian regions, as well as the location of the assemblages on surfaces believed to be of post-Pleistocene deposition, suggest that most of the stone artefacts in surface scatters are relatively recent, dating to the mid/late Holocene (Hughes and Hiscock 2005, Mitchell, 2005).

Archaeological investigations at ODO3A23

Two 1 m grid square transects were placed through two surface artefact clusters at ODO3A23, one on the western and one on the eastern side of the blowout (Figure 2), each in a minor depression within the blowout. The total area from which artefacts were collected from the surface and the underlying 100mm of sand was 138 m^2. The artefact densities of this surface and near-surface scatter were 20/m^2 in the western transect and 27/m^2 in the eastern transect.

On the western margin of the blowout, stone artefacts appeared to have been buried by sand that had cascaded down its rim. The extension of an artefact layer from a blowout into the slumped/windblown sand on its margin is similar to the situation reported from another

site in a blowout at Olympic Dam (H364) by Mitchell (1985) who did not attempt to date the artefact layer within the dune.

In order to date this buried artefact layer, two 6 m X 1 m excavation areas were gridded on the western margin of the blowout (Figure 2). All surface artefacts and manuports were collected within the grid squares, and the sand deposits were excavated in horizontal 100 mm-deep spits and sieved to recover artefacts, to trace any artefact layer in its stratigraphic context and to obtain datable sediment samples. Excavations continued until culturally sterile sediments were reached at a maximum depth of 800mm.

In the southern trench, artefacts occurred only on the surface and in the top 50-100mm of loose sand. No OSL samples were collected from this trench.

In the northern trench an upper root-penetrated layer of red sand thickened upslope from about 50mm to 400mm. This upper sand retained visible thin near-horizontal aeolian bedding, suggesting it was very recent, as the sand had not yet been subject to appreciable bioturbation. Below 400 mm the deposit was undifferentiated loose red well-sorted medium quartz sand, and there was a sharp break between the bedded sand and the undifferentiated sand. Almost all the stone artefacts were recovered from the base of the bedded surface sands, concentrated in a layer at that break.

Sediment 'core' samples were collected for OSL dating from the northern trench using opaque PVC cylinders, 50 mm in diameter and 200 mm long. Three cylinders were inserted horizontally into the southwestern wall of the excavation trench (Figure 2), to sample the base of the bedded upper sediments (400 mm below surface), the sand immediately below that bedding (500 mm) and the undifferentiated sand near the base of the excavation (700 mm). A fourth core was inserted vertically into the excavation floor, about 1 m below the ground surface to obtain the earliest date that could be ascertained from this excavation (Table 1).

OSL sample preparation
Standard procedures for obtaining quartz grains were followed for the OSL determinations.

- Sample preparation was conducted under subdued indirect red lighting.
- Only the unexposed central material from the cylinders was used for luminescence measurements.
- Moisture content was determined from 100g voucher samples taken to provide a backup of material.
- The samples were dry-sieved mechanically through nested brass sieves into several grain size fractions. Only the 180-212µm grains were used for analysis as these fit into the 300µm holes in the single-grain disks.
- The grains were first treated with hydrochloric acid and hydrogen peroxide to remove carbonate and organic materials. No reaction was visible with either.
- A 40 minute hydrofluoric acid etch was employed to remove outer surfaces of the grains (which might be subject to external alpha radiation) and to reduce feldspars. The grains were treated again with HCl and then resieved to remove any remnant feldspars.
- A density separation using a metalithium-tungstate solution of 2.67 specific gravity) was used to remove heavy minerals.

Luminescence analysis

Luminescence dating relies on the principle that materials absorb energy from naturally occurring ionising radiation and release that energy, in part as luminescence, with exposure to light or heat (Aitken 1998). The intensity of the luminescence signal is proportional to the time since the last exposure. Dose rate (D_R), the denominator for the equation to calculate age, is the average radiation dose that a sample is exposed to over time. This includes alpha, beta, gamma and cosmic radiation, although for etched quartz grains the alpha contribution is negligible. The primary terrestrial sources of radiation are ^{40}K, ^{238}U, and ^{232}Th. The numerator in the age equation is the equivalent dose (D_E): the radiation dose necessary to produce a luminescence signal equal to the natural signal measured in the laboratory. The equation:

$$\textbf{Age}(\text{ka}) = \mathbf{D_E}\ (\text{Gy})/\mathbf{D_R}\ (\text{Gy/ka})$$

is used to determine age in thousands of years (ka), D_E is measured in grays (the international unit for absorbed dose, in J/kg) and D_R is measured in grays per thousand years.

Grains were placed onto five discs (eight discs for U2556) for single-grain measurement. One disc from each sample was used to measure dose recovery, and the other four for equivalent dose.

Luminescence was measured on a Risø TL-DA-15 reader with single-grain attachment. Stimulation was by a 532 nm laser delivering 45 W/cm^2. Detection was through 7.5 mm U340 (ultraviolet) filters. Exposure was for 0.8 s on each grain at 125°C. The first 0.06 s was used for analysis and the last 0.15 s for background. A preheat of 240°C for 10 seconds followed each dose, except for the calibrating test doses after which a 200°C for 1 second preheat was employed. The test dose was about 3 Gy. Doses were delivered by a 90 Sr beta source which provides about 0.1 Gy per second to coarse-grained quartz.

Equivalent dose (D_E) was estimated using single aliquot regeneration (SAR) protocol on single grains (Murray and Wintle 2000, Wintle and Murray 2006). The SAR method which measures the natural signal and that from a series of regeneration doses, provides three benefits for D_E calculation (Murray and Wintle, 2000; Wintle and Murray 2006). It makes extrapolation of values to determine ages unnecessary, it includes a correction for sensitivity changes and it allows for samples containing mixed sediments to be identified. The method uses a small test dose to monitor and correct for sensitivity changes brought about by preheating, irradiation or light stimulation.

SAMPLE	DEPTH (mm)	COMPONENT 1		COMPONENT 2		COMPONENT 3		CENTRAL AGE MODEL (ka)
		De (Gy)	%	De (Gy)	%	De (Gy)	%	
UW2555	395	0.24±0.05	63.4	2.47±0.15	11.4	6.01±0.23	25.2	5.09 ± 0.68
UW2556	495	3.36±0.18	4.8	5.35±0.10	61.4	7.40±0.21	33.8	12.1 ± 1.28
UW2557	645	5.01±0.26	42.5	6.50±0.31	47.9	11.0±0.63	9.6	13.9 ± 1.59
UW2558	845	4.66±0.13	38.2	6.30±0.19	42.1	8.50±0.34	19.8	12.8 ± 1.40

Table 2. Components containing highest percentage of sample measurements and central age model for ODO3A23 samples.

Single-grain analysis also provides the opportunity to remove from analysis grains with unsuitable characteristics. Grains were eliminated if they had poor signals (errors on the test dose greater than 30% or from net natural signals not at least three times above the background standard deviation); did not produce within 20% the same (recycling) signal ratio from identical regeneration doses at the beginning and end of the SAR sequence; yielded natural signals that did not intersect saturating growth curves; had a signal larger than 10% of the natural signal after a zero dose; or contained feldspar contaminates (judged visually on growth curves by a reduced signal from infrared stimulation on two doses).

The luminescence signal from quartz has multiple components, some bleaching more rapidly than others. Linearly-modulated OSL (where the laser power is ramped from 0 to 90% in 30 seconds) allows visual separation of the components and identification of those grains dominated by other than the fast-bleaching component. This minimises the effect of partial bleaching, where sunlight is inadequate to reset the signal (Murray and Wintle 2000). Linearly-modulated OSL was measured for each grain at the end of each SAR sequence. Grains dominated by other than the fast component were marked, and if the D_E from these differed significantly from those of fast-component grains, they were removed from analysis.

A dose recovery test was performed on some grains. Their luminescence was removed by exposure to the laser, a dose of known magnitude administered and the SAR procedure was applied to see if the known dose could be obtained.

A D_E value was obtained for each suitable grain. Because of varying precision, a distribution is produced. Two statistical tools - the common age model and central age model (Galbraith *et al.* 1999, 2005) are used to evaluate D_E distributions. The common age model controls for differential precision by computing a weighted average using log D_E values. The central age model assumes a natural distribution of D_E values, because of non-statistical sources of variation, and computes an over-dispersion parameter (σ_b) as the relative standard deviation (or coefficient of variance) of the true D_E values: deviation beyond that accounted for by measurement error. Empirical evidence suggests that σ_b of between 10 and 20% is typical of single-aged samples (Olley *et al.* 2004; Jacobs *et al.* 2006). For samples of mixed ages either a minimum age model or a finite mixture model is used. The minimum age calculates a statistical minimum using a truncated normal distribution and is suitable for partially bleached samples. The finite mixture model may be used if post-depositional processes have discrete age populations. It uses maximum likelihood to separate grains into single-aged components based on the input of a given σ_b value and the assumption of a log normal distribution of each component. The model estimates the number of components, the weighted average of each component, and the proportion of grains assigned to each. The model provides two statistics for estimating the most likely number of components, maximum log likelihood (llik) and Bayes Information Criterion (BIC).

Dose rate determinations

Radioactivity was measured by alpha counting, beta counting and, for K, atomic emission. Samples for alpha counting were crushed, packed into plexiglass containers with ZnS:Ag screens, and sealed for one month. The pairs technique was used to separate the U and Th decay series. For atomic emission measurements, samples were dissolved in hydrofluoric and other acids and analysed by a Jenway flame photometer. K concentrations for each sample were determined by bracketing between standards of known concentration. Conversion to ^{40}K was by natural atomic abundance. Radioactivity was measured by beta counting using a Risø low level beta GM multicounter system for 24 hours. The average was converted to dose rates following Bøtter-Jensen and Mejdahl (1988) and compared with the beta dose rate calculated from alpha counting and flame photometer results. Cosmic radiation was determined after Prescott and Hutton (1988) using site latitude, longitude and altitude. Radioactivity concentrations were translated into dose rates following Adamiec and Aitken (1998).

Age was calculated using a laboratory-constructed spreadsheet based on Aitken (1985). Error terms were computed at one-sigma. These measurements are detailed in Table 1.

Dosimetry results

The concentrations of the major radionuclides are given in Table 1, along with the total dose rate. Also given is the beta dose rate calculated in two ways: directly from beta counting and indirectly from alpha counting and flame photometry. These are in agreement for three samples. A small discrepancy for UW2558 may reflect some disequilibrium, but whatever the cause, beta counting, as a direct measure, is considered more accurate and was used for the beta dose rate in age calculation. Moisture content was taken to be 2 ± 2 %, which reflects the measured amount. The dose rates for all samples are low, reflecting a composition dominated by quartz. The low dose rates mean that the relative cosmic dose contribution is high, about 45%, increasing uncertainty.

Equivalent dose (D_E) was measured on single-grains using 180-212µm quartz. About 500 grains were measured for each sample, with 700 measured for U2556. These were all used for equivalent dose determination except for 100 grains from UW2556, which were used for dose recovery. The acceptance rate was relatively high: 41.2% for UW2555, 28.7% for UW2556, 19.8% for UW2557, and 32.2% for UW2558. A total of 42 grains from the 100 grains of UW2556 were acceptable for dose recovery. For the latter the administered dose was 40s of beta irradiation, and the central tendency of the recovered doses was 40.8 ± 0.9s, with an over-dispersion of 5.3%. This suggests that the procedures were working properly. The 5.3% over-dispersion is the minimum dispersion that might be expected for a single-aged sample, due to variations in luminescence from grain to grain, machine scatter, or other measurement variables. All extrinsic sources of over-dispersion – different depositional ages or differential dose rate – are controlled in dose recovery, so over-dispersions above about 5% in the natural D_E distributions can be attributed to these extrinsic factors.

The natural distributions are summarised in Table 1. This gives the number of grains for which a D_E could be derived, the central tendency expressed as the central age model, and the over-dispersion (σ_b (%)). Over-dispersion was not high for three of the samples, but it was higher than the 5% from dose recovery, so some extrinsic factors are involved. The over-dispersion for UW2555 is very high so a finite mixture model was applied, using 5% over-dispersion to account for intrinsic factors. The number of components derived is a function of extrinsic factors only. Table 2 gives for each sample the D_E value for each component as well as the proportion of grains assigned to each.

Some over-dispersion is due to differential dose rate. The D_E is measured on single grains but the dose rate used to determine age is the bulk value from the sample. The beta dose rate may vary at the scale of single grains depending on the distribution of radioactive sources relative to the individual grains. For sandy sediments where potassium feldspars are sparse and unevenly distributed, grains close to them will have a higher ^{40}K dose rate than those further away. A simulated model (Mayya *et al.* 2006) was applied to determine a probable minimum dose rate for grains far from beta sources, based on the percentage of ^{40}K in the samples and the proportion of the total dose rate contributed by betas. (Long-range gamma radiation does not normally produce heterogeneous dose rates, and short-range alpha radiation is not significant for coarse-grained quartz.) The D_E value from the lowest component was divided by this minimum dose rate and the age compared with the age of the second component.

For UW2557 and UW2558, this procedure produced no significant difference in age between the first and second components, suggesting beta heterogeneity could account for the difference. This was not true for the second and third components, suggesting older grains were present, but the third component is relatively small and some of it may be accounted for by differential dose rate. Both samples are therefore close to being single-aged samples, and the central age model, which averages out differences in beta dose rates, is a good estimate for deriving the age of deposition.

For UW2556, beta heterogeneity cannot account for the difference between the first and second components. The first component is small and consists of grains derived from the sediments just above the sample. The difference between the second and third components, when accounting for differential beta dose rate, was low (not significant at two sigma), suggesting some mixing of older grains. This sample is nevertheless close to being single-aged, and the central age model provides the best estimate. The central age D_E values for UW2556, UW2557 and UW2558 are statistically identical, indicating that the homogeneous sand at the base of the excavation was deposited rapidly.

An example of the nature of the D_E distribution can be seen in Figure 3, the radial plot for UW2558. Radial graphs plot precision on the x-axis against a standardised value (the number of standard deviations any point is away from some reference) of D_E on the y-axis. The UW2558 graph shows the reference, the central age (similar to the second component), the first component and the third component. The shaded area around the central age represents a two standard deviation envelope so all points falling within it are within two standard deviations of the central age. A line drawn from the origin through any point intersects the right-hand axis at the non-standardised value. The graphs for the three samples showed uniform scatter around the central age, with no indication of separate modes.

This was not the case for the highly dispersed UW2555, which showed at least two modes. The lowest mode consists of low value, low precision grains that form the

first component. More than half the grains (86) yielded negative D_E values, a statistical artefact of modern grains. The central age represents the average of these modern grains and the two older modes, and accounts for very few grains on its own. The third component of UW2555 has a D_E value close to that of the central age of the other three samples and derives from the underlying homogeneous sand, just as some of the upper sands found their way into UW2556. That left the second component as the only mode not derived from somewhere else. Although it represents only 11.4% of the grains, it may provide the age of a real population in the sample.

OSL Ages

Table 2 gives the derived ages based on the central age model for the bottom three samples and a component of UW2555. The ages for the bottom three samples (12.1 ± 1.28, 13.9 ± 1.59 and 12.8 ± 1.40 ka) are statistically indistinguishable. These three ages indicate that the homogenous sand below the visible bedding is a slightly bioturbated deposit that formed during the Late Pleistocene.

The UW2555 sample is mainly modern sand, as indicated by predominantly zero age values but it contains older grains with a wide variety of ages. The second component with an age of about 5 ka may represent a sand layer deposited at that time, or it may reflect admixing of older sand into an effectively modern deposit.

Discussion

The best interpretation of sample UW2555 is that it is mostly modern, and the small older populations in that sample are the result of bioturbation. This conclusion is based on the proportions of grains in the various populations.

As it is reasonable to take the proportions of single grains in each population as representing the relative proportions of the full sediment body in each age category, the majority of that upper sand unit is not severely bioturbated. This is consistent with the strong field evidence - fine laminations remain which cannot survive mass turnover of the unit. The older populations of grains in this sample (possibly including one with an age of about 5 ka) are the result of bioturbation at the base of the unit, introducing material from the underlying unit. The grains in the top portion of that underlying unit will themselves have undergone bioturbation before the modern sand arrived to cap them, so the upper portion should also show some ages as near-modern, with others indicating the true deposition age.

The four dates reveal a disconformity between the two sand units. The youngest age on the lower unit is 12.1 ka and the upper unit is modern, albeit with grains that might indicate some deposition at about 5 ka, but should probably be interpreted to mean there was no identifiable deposition at this location during the Holocene. The cause of the commencement of modern sedimentation has been described in detail by Badman (1999) – heavy stocking of cattle and the spread of feral animals, especially rabbits, led to widespread surface erosion and sand mobilisation in the Lake Eyre South catchment between the 1870s and the 1940s. The upper bedded aeolian sand more than 500 mm deep, trapped by vegetation on the rims of dune blowouts, is a result of that sand mobilisation following the arrival of European pastoralists in the 1870s.

Artefacts were recovered from the sediment immediately overlying the surface buried by the UW2555 sample, demonstrating that they were deposited during the Holocene, and possibly within the last 5,000 years. Such an age is consistent with the majority of dates for human occupation of sand deserts elsewhere in Australia, where evidence has suggested a substantial expansion of human activity in the last few millennia (Smith 1993, 2006; Veth 1989; Veth et al. 2001). A set of dates from a single blowout on a single dune however is insufficient to draw conclusions beyond the local level. Further dates from Olympic Dam in deeper stratigraphic contexts will provide information on the recent evolution of the sand dunes and the timing of human occupation in this part of the Australian desert.

Numerous knapping floors on quartzite, silcretes and cherts were identified in the blowout during the investigations, suggesting the stone knappers had been sitting in it, as it is unlikely the tightly clustered features could have been let down in that form by deflation. Less activity took place on the blowout rim as artefact densities, which were 20 and 27 artefacts/m² on average in the blowout, diminished on the margins. In the northern excavated trench (Figure 2) densities decreased away from the blowout floor from 23 to 8/m². The trend was more obvious in the southern trench where artefact densities fell over 6 m from 23/m² near the blowout floor to 5/m² on the rim. Windblown sand has buried artefacts on the rim of the depression indicating that apart from recent sand deposition at its margins, the form of the blowout has changed little since it was occupied.

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References

- Adamiec, G., and Aitken, M.J. 1998. Dose rate conversion factors: update. *Ancient TL* 16:37-50.
- Aitken, M.J. 1985. *Thermoluminescence Dating*, Academic Press, London.
- Aitken, M.J. 1998. *An Introduction to Optical Dating*. Oxford University Press, London.

- Badman, J.J. 1999. In W. J. H. Slaytor (ed.) Lake Eyre South monograph series volume 6: Archaeology of the Lake Eyre South region. Royal Geographic Society of South Australia
- Bøtter-Jensen, L, and Mejdahl, V. 1988. Assessment of beta dose-rate using a GM multi-counter system. *Nuclear Tracks and Radiation Measurements* 14:187-191.
- Cupper, M.L. 2005. Last glacial to Holocene evolution of semi-arid rangelands in southeastern Australia. *The Holocene* 15(4):541-553.
- Field, T., Marwick, B., Feathers, J. and Przystupa, P. 2011. Four luminescence dates from quartz sand excavated from archaeological site ODO3A23, arid northeastern South Australia. Unpublished report to HEH P/L through Department of Anthropology, University of Washington. June 2011.
- Fitzsimmons, K.E., Rhodes, E.J., Magee, J.W. and Barrows, T.T. 2007. The timing of linear dune activity in the Strzelecki and Tirari Deserts, Australia. *Quaternary Science Reviews*, 26(19-21): 2598-2616.
- Galbraith, R.F., Roberts, R.G., Laslett, G.M., Yoshida, H., & Olley, J.M. 1999. Optical dating of single and multiple grains of quartz from Jinmium rock shelter, northern Australia: Part I, experimental design and statistical models. *Archaeometry* 41:339-364.
- Hesse, P.P., Magee, J.W. and van der Kaars, S. 2004. Late Quaternary climates of the Australian arid zone: a review. *Quaternary International* 118-119:87-102.
- Hollands, C., Nanson, G.C., Jones, B.G., Bristow, C.S., Price, D.M. and Pietsch, T.J. 2006. Aeolian–fluvial interaction: evidence for Late Quaternary channel change and wind-rift linear dune formation in the northwestern Simpson Desert, Australia. *Quaternary Science Reviews* 25:142–6
- Hughes, P.J. and Hiscock, P. 2005: The archaeology of the Lake Eyre South area. In W. J. H. Slaytor (ed.) *Lake Eyre South monograph series volume 6: Archaeology of the Lake Eyre South region*. Royal Geographic Society of South Australia, 1-20.
- Hughes P., Hiscock, P., Sullivan, M. and Marwick, B. 2011. Archaeological investigations at Olympic Dam in arid northeast South Australia. *Journal of the Anthropological Society of South Australia Special Edition Issues in South Australian Aboriginal Archaeology* 34:21-37.
- Jacobs, Z., Duller, G.A.T. and Wintle, A.G. 2006. Interpretation of single grain De distributions and calculation of De. *Radiation Measurements* 41:264-277.
- Lomax, J., Hilgers, A., Twidale, C.R., Bourne J.A. and Radtke, U. 2007. Treatment of broad palaeodose distributions in OSL dating of dune sands from the western Murray Basin, South Australia. *Quaternary Geochronology* 2(1-4):51-56.
- Mabbutt, J.A. 1977. *Desert Landforms*. Australian National University Press, Canberra, 340p.
- Magee, J.W., Miller, G.H., Spooner, N.A., and Questiaux, D. 2004. Continuous 150000 yr monsoon record from Lake Eyre, Australia: Insolation-forcing implications and unexpected Holocene failure. *Geology*, 32(10):885.
- Mayya, Y.S., Morthekai, P., Murari, M.K. and Singhvi, A.K. 2006. Towards quantifying beta microdosimetric effects in single-grain quartz dose distribution. *Radiation Measurements* 41:1032-1039.
- Mitchell, S. 2005. Archaeological Excavations at Olympic Dam, South Australia. In W.J.H. Slaytor (ed.) *Lake Eyre South monograph series volume 6: Archaeology of the Lake Eyre South region*. Royal Geographic Society of South Australia, 21-72.
- Murray-Wallace, C.V., Banerjee, D.B., Bourman, R.P., Olley, J.M. and Brooke, B.P. 2002. Optically stimulated luminescence dating of Holocene relict foredunes, Guichen Bay, South Australia. *Quaternary Science Reviews* 21(8-9):1077-1086.
- Murray, A.S., and Wintle, A.G. 2000. Luminescence dating of quartz using an improved single-aliquot regenerative-dose protocol. *Radiation Measurements* 32:57-73.
- Nanson, G.C., Chen, X.Y. and Price, D.M. 1992. Lateral migration, thermoluminescence chronology and colour variation of longitudinal dunes near Birdsville in the Simpson Desert, central Australia. *Earth Surface Processes and Landforms* 17(8) 807-819.
- Nanson, G.C., Chen, X.Y. and Price, D.M. 1995. Aeolian and fluvial evidence of changing climate and wind patterns during the past 100 ka in the western Simpson Desert, Australia. *Palaeogeography, Palaeoclimatology, Palaeoecology* 113:87–102.
- Olley, J.M., Pietsch, T., & Roberts, R.G. 2004. Optical dating of Holocene sediments from a variety of geomorphic settings using single grains of quartz. *Geomorphology* 60:337-358.
- Prescott, J.R., and Hutton, J.T. 1995. Environmental dose rates and radioactive disequilibrium from some Australian luminescence dating sites. *Quaternary Science Reviews* 14, 439-448.
- Rhodes, E.J. 2011. Optically stimulated luminescence dating of sediments over the past 200,000 years. *Annual Review of Earth and Planetary Sciences* 39(1)461-488.
- Smith, M.A. 1993. Biogeography, human ecology and prehistory in the sandridge deserts. *Australian Archaeology* 37: 35-50.
- Smith, M.A. 2006. Characterizing Late Pleistocene and Holocene stone artefact assemblages from Puritjarra rock shelter: A long sequence from the Australian Desert. *Records of the Australian Museum* 58: 371-410.
- Twidale, C.R., Prescott, J.R., Bourne, J.A. and Williams, F.M. 2001. Age of desert dunes near Birdsville, southwest Queensland. *Quaternary Science Reviews* 20:1355–64.
- Veth, P. 1989. Islands in the interior: a model for the colonization of Australia's arid zone. *Archaeology in Oceania* 24: 81-92.
- Veth, P., Smith, M. and Haley, M. 2001. Kaalpi, the archaeology of an outlying range in the dunefields of the Western Desert. *Australian Archaeology* 52: 9-17.
- Wintle, A.G., 2008. Fifty years of luminescence dating. *Archaeometry* 50:276-312.
- Wintle, A.G. and Murray, A.S., 2006. A review of quartz optically stimulated luminescence characteristics and their relevance in single-aliquot regeneration dating protocols. *Radiation Measurements* 41:369-391.

Australasian Quaternary Association (AQUA) Biennial Meeting

Lake Tekapo, New Zealand
12th-17th February 2012

Tom Brookman, Alice Doughty and Louise Moody

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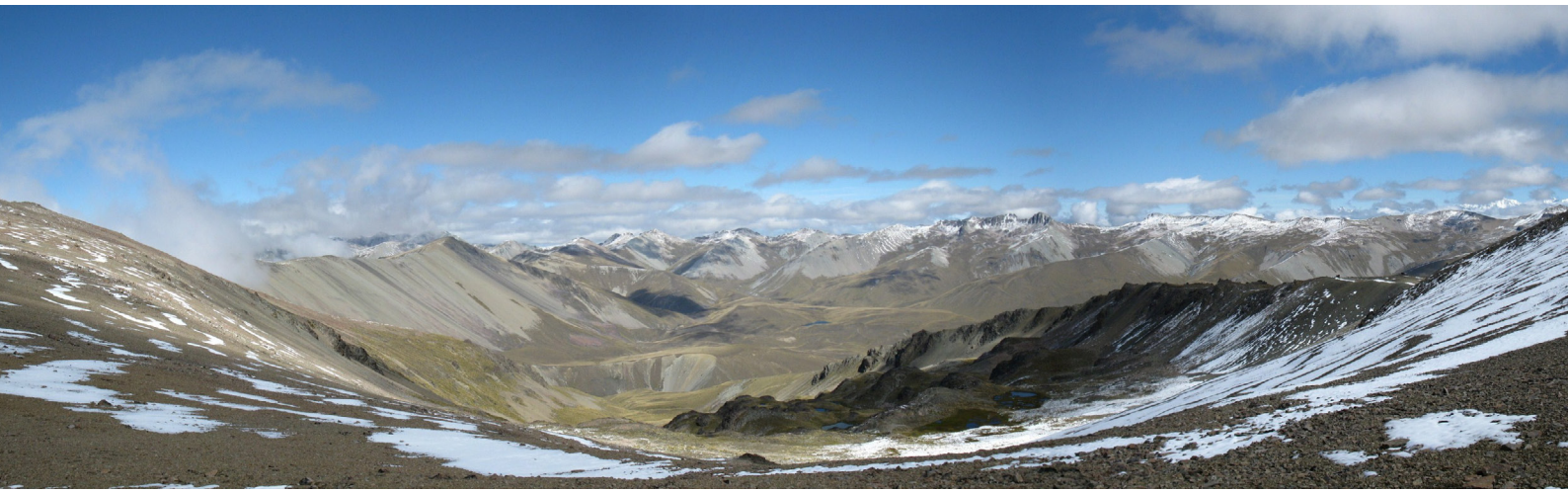

Figure 1. Mackenzie country panorama (photograph by Tom Brookman)

It is not often you get up before dawn on Monday to drive to work brimming with excitement for the week ahead but when the car is a rugged old Hilux, the workplace is the beautiful glacial landscape of the Mackenzie Country (Figure 1) and the work is a week of palaeoclimatology, geomorphology, field trips and good company… well, exceptions can be made! Tekapo provided a beautiful day to welcome the AQUA biennial meeting back to New Zealand's shores after many years of meeting on the large Western Island. Approximately 40 of Australasia's Quaternary community, ranging from its founders to complete new-comers, gathered at Pepper's Bluewater Resort to report and discuss recent developments in Quaternary science covering subjects from advances in geochemical methods to Mediterranean ocean cruises, sometimes referred to as 'scientific expeditions'.

Appropriately, Monday morning began with David Barrell's (better known as Darrel, but that's a story for another time) keynote introduction to the dynamic Quaternary setting for the conference, the Mackenzie Country of the central South Island. The presentation provided a vehicle for the unveiling of the wonderful new set of GNS geomorphological maps of the area. The morning continued along a similar theme, degenerating briefly into a session of comparing the length of each-others' corers with Marcus Vandergoes' entertaining keynote documenting extensive recent fieldwork undertaken in the Mackenzie Basin Lakes, expanded upon in Phaedra Upton's follow-up presentation.

After a hearty lunch, the afternoon developed a distinctly more Australian flavour of dust transport, deserts and Aboriginal land-use histories. These, coupled with Craig Sloss' holiday photos documenting the IODP (Integrated Ocean Drilling Program) Expedition to the Mediterranean Outflow, left everyone in high spirits at the end of the day. All of that outback air and dazzling salt water left some people with a thirst so they continued their discussions at the local watering hole while others retired to put the finishing touches on, or lay foundations for, their upcoming presentations.

Luckily for those whose presentations were less than complete, Tuesday was scheduled for the mid-conference field-trip. Having started the conference with a marvellous day it was only appropriate that New Zealand's famously changeable weather serve up a dose of LGM summer conditions, with cold southerlies greeting the hardy Quaternary souls touring the wonderful glacial surroundings (see separate report by Stephanie Kermode).

Figure 2. (TOP) Lake Pukaki, looking north toward Mt. Cook. (ABOVE) View from the observatory on Mt. John with Lake Alexandria and Lake Tekapo in the background (photographs by Alice Doughty).

"Fresh" from a day of sight-seeing (Figure 2) or palaeoseismic trenching, participants returned to Tekapo for a night of revelry. A geographical division occurred as the Australians disappeared to create havoc in the township while the Kiwis, both native and adopted, retired to Chez Lorrey for a civilised evening of fine wine, boutique beer and haute cuisine prepared by the resident chef. Deeply scientific discussions included brewing, soil science, fermented grape juice, biogeochemical climate proxies, the seismic history of the Fox Peak fault and whether raw onion detracted from, or added to, a salad.

Another gloomy day couldn't dampen the bright spirits of the Quaternarists who again congregated at the bus stop the following day, this time to travel to nearby Twizel for the SIRG (Snow and Ice Research Group of New Zealand) meeting that was taking place concurrently. SIRG meets every year in February to discuss the latest and greatest of research in their fields. The conference is largely student-oriented, with students dominating the presentation line-up (~70%) and meeting organisers securing funds to make registration free for students. University of Otago, Victoria University, and Canterbury University alternate each year in organising the conference and attendees also travel from Massey, GNS Sciences, and NIWA as well as from abroad.

Oliver Marsh from Canterbury University was the main organiser for 2012 with Daniel Price, Heather Purdie, and Wolfgang Rack on the committee. They secured this year's sponsors, who were Meridian Energy, NIWA, Antarctica New Zealand, Glacier Explorers, Sir Ed Hillary Alpine Centre, and the International Glaciological Society. The meeting included two days of talks, a half-day of field trip (Figure 3) (with a boat ride on the Tasman Lake and a walk around the Kettle Hole in the Pukaki LGM terminal moraine), a special dinner at Glentanner Park Cafe, and down time for discussions. The range of topics covered included remote sensing, glacier dynamics, sea ice, Antarctica, and mass balance. The International Glaciological Society president, Doug MacAyael (University of Chicago), attended the meeting as part of his mission to visit as many local branch meetings as possible this year around the world. Other overseas visitors came from the Australian Antarctic Division, the University of Munich, and the University of Queensland.

On Wednesday morning at the Lake Ruataniwha Rowing Complex in Twizel, AQUA and SIRG joined forces for the first time. SIRG welcomed the visitors and Peter Almond introduced the AQUA group goals and interests. The presentation session, entitled "New Zealand glacier dynamics," included talks by Robert Dykes (Massey), Todd Redpath (Otago), Brian Anderson (VUW), Andrew Mackintosh (VUW), Laura Kehrl (VUW), Ekki Scheffler (UCant), Sebastian Vivero (Otago), Tim Kerr (NIWA), and Pascal Sirguey (Otago). For those who walk the line between glaciology and palaeoclimate, the joining of the groups was a welcome sight.

Figure 3. Alice Doughty and Heather Purdie at the Lake Pukaki LGM terminal moraine interpretation lookout (photograph by Shaun Eaves).

Figure 4. AQUA attendees engaged in social science at the A-frame house - before and after (photographs by Fiona Shanhun).

After another long day of travel (to and from SIRG) and thought-provoking presentations it was only natural that Quaternarists indulge in some revelry, so it was off to "the A Frame House" for a barbeque, kindly organised by Darrel (Figure 4). More Quaternary discussions ensued with newly integrated SIRG members providing fresh faces and perspectives. Lincoln University soil scientists Rachel and Scott determined the outcome of a pressing palaeoseismological question, "how many tons of earth had Tim and Tom moved in their recent trenching?", while Rewi Newnham paused his pondering of "whether there should be a formal subdivision of the Holocene" to investigate the ecophysiological effects of feeding horses left-over sandwiches. A merry time was had by all, culminating in conference convenor Peter Almond having to bodily haul his co-organiser and recently graduated PhD student Andre Eger from his temporary accommodation on the lawn.

Thursday morning kicked off with Allan Chivas as keynote speaker, enlightening us about clumped-isotope theory and causing a stir with the idea that dinosaurs were in fact warm blooded! This set the mood for a morning of isotope-based studies, involving a range of climate proxies from Australia, New Zealand, East Timor and Patagonia. New research provided interesting food for thought, covering topics including New Zealand palaeotemperatures recorded by speleothems, Holocene polar inter-hemispheric asymmetry visible in Australian sediment cores, oceanic conditions recorded by modern and Pliocene tropical corals, methodological challenges in dendroclimatology using kauri trees, global ^{13}C dilution visible in Australian speleothems, and Patagonian vegetation changes through time in response to climatic and volcanic events. Attention was brought back to the local region with the details of Schmidt-hammer and trench digging antics in the Mackenzie Basin, with implications for active tectonics appealing to all after Darrel's highly successful conference fieldtrip. A poster session over lunch kept us on our toes, with tales of environmental change, hillslope evolution and paleosol sequences from Australia and further afield to Antarctica and Hungary. The afternoon sessions transitioned to the latest INTIMATE research, beginning with an overview of OZ-INTIMATE climate event stratigraphy and a Southern Ocean review before moving to a New Zealand glacial theme of Southern Alps climate and the stratigraphy of the West Coast during the Pleistocene.

Friday morning started a little slowly for some, after much enjoyment of boutique beer (which Peter Almond insisted must be consumed from a glass), red wine and Thai food in a spectacular lakefront setting at the conference dinner the night before. A special mention must go to the Quizmasters Darrel and Tarrows, who entertained and challenged us (some more than others) for several hilarious hours. The final session of Holocene-inspired research began with Rewi Newnham as keynote speaker, debating whether or not there should be a formal subdivision of the Holocene. This provided a good basis for discussions around Quaternary sea level rise, constraining lake cores using tephra beds, a mid-Holocene circulation transition in New Zealand and ice loss estimates in Antarctica. Presentation of the student awards followed these final talks, with everyone leaving the conference venue having gained insights into many new and exciting areas of research. We were able to make the most of the stunning weather with a lakeside picnic lunch at the Church of the Good Shepherd; a wonderful way to wrap up the conference and reflect on new ideas shared, friends made and countryside visited during a great week spent on the beautiful South Island.

AQUA 2012, Mid-Conference Field Trip Report

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Figure 1. Contact between the Mount John outwash plains and the Tekapo till at Pukaki Dam.

Entitled "A few long cold ones", the mid-conference field trip for AQUA 2012 was destined to be thoroughly enjoyable. For those keen to experience typical New Zealand conditions in addition to local Quaternary wonders, their expectations were certainly met. Despite the thick, low cloud cover, and of course rain, everyone began the day with chipper spirits. Set in the Mackenzie Basin of the impressive South Island, we were embarking on a journey to compare evidence from glacial cycles in the Lake Pukaki catchment. After Peter Almond managed to successfully count the number of people on the bus, we departed Lake Tekapo and headed to Pukaki Dam. Along the way we were able to observe the Tekapo moraines before travelling on to the Mount John outwash plains, and then to the more subdued Balmoral and Wolds moraines. Of note, given the subdued expression of the Wolds moraines in particular, is that this current morphology does not relate to subsequent deposition of loess, as such deposits seldom exceed 2 m thickness (Maizels, 1989).

The first stop at Pukaki Dam displayed a nice exposure of a diamicton deposit, a mixture of outwash gravels and lacustrine sediments formed by the advance,

Figure 2. View of Mueller Glacier lake.

retreat and glacial re-advance associated with the Tekapo event. These deposits represent Tekapo till that was forced over gravels of the Mount John outwash plains (Figure 1). Two things are significant here. Firstly, following the initial period of aggradation of Mount John outwash gravels, there must have been adequate ice sheet retreat to permit deposition of lacustrine silts. Secondly, the Tekapo-age re-advance reworked this lake sediment as till (Hart, 1996), to overlie the Mount John outwash deposits. The Gondwanan origin of the boulder material ensured that the rivalry of ownership of the western half of New Zealand began in earnest early in the day.

The Pukaki hydro scheme is of critical importance to of New Zealand's energy supply, responsible for supplying one quarter of the country's requirements. The 179 km^2 dam is therefore kept at 53m above natural lake levels to ensure sufficient store in the event of reduced rainfall. Incidentally, if it failed there would be major nation-wide power cuts, as well as the failure of the three dams downstream (Ohau A, Benmore and Aviemore), which are also significant energy producers.

An interesting aside was the discussion as to why glacial lakes are so blue. Popular opinion has held that it is the fine glacial rock flour and diffraction of light. John Chappell, who unfortunately was unable to attend, proposed some years ago that since non-turbid lakes also appear blue, there must be an alternative explanation. He suggested that bicarbonates in the systems contribute, which if dissolved would produce an ion which would diffract the light to appear blue. Work has been conducted by Paul Hesse to examine this, and although inconclusive, initial results suggest that these lakes tend to be alkaline; by comparison, acidic lakes appear brown in colour (P. Hesse, pers. comm.). Our enthusiastic discussion at the first site meant that we were running behind schedule, thus our Ostler Fault visit was limited to a drive-by viewing as we travelled along Max Smith Drive.

Next up was the stop at Boundary Stream. Although our AQUA field trip was not quite on the same scale as the NOAA field trip a few years back, where helicopters were hired, we must be thankful for their budget, since it was during these flights that Marcus Vandergoes observed a small kettle lake, often now referred to as Boundary Stream tarn. Pollen and chironomid analysis from this lake has provided a detailed late-glacial palaeoecological and palaeoclimate record (Vandergoes et al., 2008). Without helicopters, 4WDs, or the time for a strenuous hike in and out, we examined the context by the side of the Mount Cook Highway. The site, at approximately 850 m ASL, is very close to the tree-line, and is therefore a very sensitive recorder of palaeoenvironments. Chironomid results provide a detailed record of the last Glacial-Interglacial

transition in the Southern Alps. This work is critical on a global scale because it establishes the connection between Antarctic and mid-latitude climate systems, and highlights the differences between the northern and southern hemispheric climate systems during the last glacial transition (Barrell and Vandergoes, 2012). Furthermore, the tarn is also a test-site, along with Macaulay Valley, for ^{10}Be cosmogenic nuclide dating (Putnam et al., 2010).

The afternoon schedule included visits to the Mueller and Tasman Glaciers, lesser known than their western counterparts. The walk to view the Tasman glacier was abandoned due to clouds obscuring the view, but the walk to view Mueller Glacier went ahead (Figure 2). Late Holocene moraines surround the glaciers, which have receded significantly during the twentieth century. The geomorphology of these glaciers has been documented, although preliminary dating of the material has proven problematic. Lichens and weathering rinds exhibit problems with calibration, although radiocarbon dating, and more recently ^{10}Be surface exposure dating, have had more success. These results highlight the significance of advances in cosmogenic techniques for Quaternary studies.

The final stop was at the Late-Otiran Mary Burn moraine lobe of the Pukaki glacier. The Mary Burn area is an agricultural region, and the Tekapo-Pukaki Canal flows through the locality. At this site, aside from discussion of moraines, we talked about another important issue, rabbit poo (Figure 3). The introduction of rabbits has caused substantial environmental problems including crop damage, ecological devastation and soil erosion, as well as disruption to nutrient cycling, although the latter effect is poorly understood. Since rabbit faeces are long-lived in the landscape, the nutrients encapsulated in these pellets is effectively removed from the nutrient cycle, causing significant stress to natural systems, and increase the need for fertilizers for agricultural crops.

An enjoyable day was had by all on this well-organised, informative and fun field trip. A big thank you to David Barrell and Marcus Vandergoes for organising the trip, as well as to Peter Almond for his valuable input. Thanks also to Drew Lorrey for setting us straight about tree-ring ages. Finally, shortly after our return home, feeling cold, wet, and a little sorry for ourselves... the skies cleared.

References

- Barrell D.J.A. and Vandergoes, M.J., 2012. *A Few Long Cold Ones – imprints of glaciers, ancient to modern, in Lake Pukaki Catchment, central South Island*. GNS Science, New Zealand. 51pp.
- Hart, J.K., 1996. Proglacial geotectonic deformation associated with glaciolacustrine sedimentation, Lake Pukaki, New Zealand. *Journal of Quaternary Science,* 11, 149-160.
- Maizels, J.K., 1989. Differentiation of late Pleistocene terrace outwash deposits using geomorphic criteria: Tekapo valley, South Island, New Zealand. *New Zealand Journal of Geology and Geophysics*, 32, 225-242.
- Putnam, A.E., Schaefer, J.M., Barrell, D.J.A., Vandergoes, M.J., Denton, G.H., Kaplan, M.R., Finkel, R.C., Schwartz, R., Goehring, B.M. and Kelley, S.E., 2010. In situ cosmogenic 10Be production-rate calibration from the Southern Alps, New Zealand. *Quaternary Geochronology*, 5, 392-409.
- Vandergoes, M.J., Dieffenbacher-Krall, A.C., Newnham, R.M., Denton, G.H., and Blaaw, M., 2008. Cooling and changing seasonality in the Southern Alps, New Zealand during the Antarctic cold reversal. *Quaternary Science Reviews*, 27, 589-601.

Figure 3. Peter Almond with a handful of nutrients.

Australasian Quaternary Association pre-conference fieldtrip

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The pre-conference fieldtrip was held on Sunday 12th February and was jointly led by Peter Almond and Philip Tonkin from Lincoln University. The theme of the trip was "Loess in Canterbury" and our tour commenced from Christchurch. I joined the coach with a small contingent at Christchurch Airport. After a slight detour to collect a fellow delegate, we headed north along State Highway 1 for ~50 km to Wairapa in North Canterbury, the location of our first stop: the Mt Cass loess section (Figure 1).

The Mount Cass loess section is a 12 m thick exposure of loess overlying sandy and gravelly alluvium. This is an important site as the loess comprises primarily carbonate, which is rare in New Zealand, and calcareous fossils, including gastropods and moa shell, are preserved in the exposure. The carbonate has been dissolved and reprecipitated and is amenable to stable isotope (C and O) analysis. The section also includes the Kawakawa-Oruanui Tephra as cryptotephra, an important marker bed for the Last Glacial Maximum. Peter Almond described the section and the work that has been carried out on the exposure to date. We were then let loose to explore the exposure close up, with many enthusiastic scientists hunting the section for fossil remains (Figure 2). Of particular interest to these hunters were fossil remains from Moa; one scientist was fortunate enough to unearth a fossil bone from a Moa, or so he assumes.

The area that we were located in (Figure 3) had recently become an important wine producing region, a point that was taken advantage of over lunch. We arrived at the Waipara Springs Winery and Cafe at 11:30 and were treated to an introductory talk about the winery and an opportunity to taste 6 wines that they had on offer. The host also mentioned fieldwork that has been carried out in the winery by colleagues from Lincoln University. It seems a fortuitous location considering the land-use of the region! Whilst sampling the 6 wines we enjoyed delicious platters of bread, meats, cheeses and fruit. Once lunch had been devoured we were ushered back onto the bus for the next leg of the journey.

We retraced our steps back to Christchurch and then headed southwest across the Canterbury Plains to

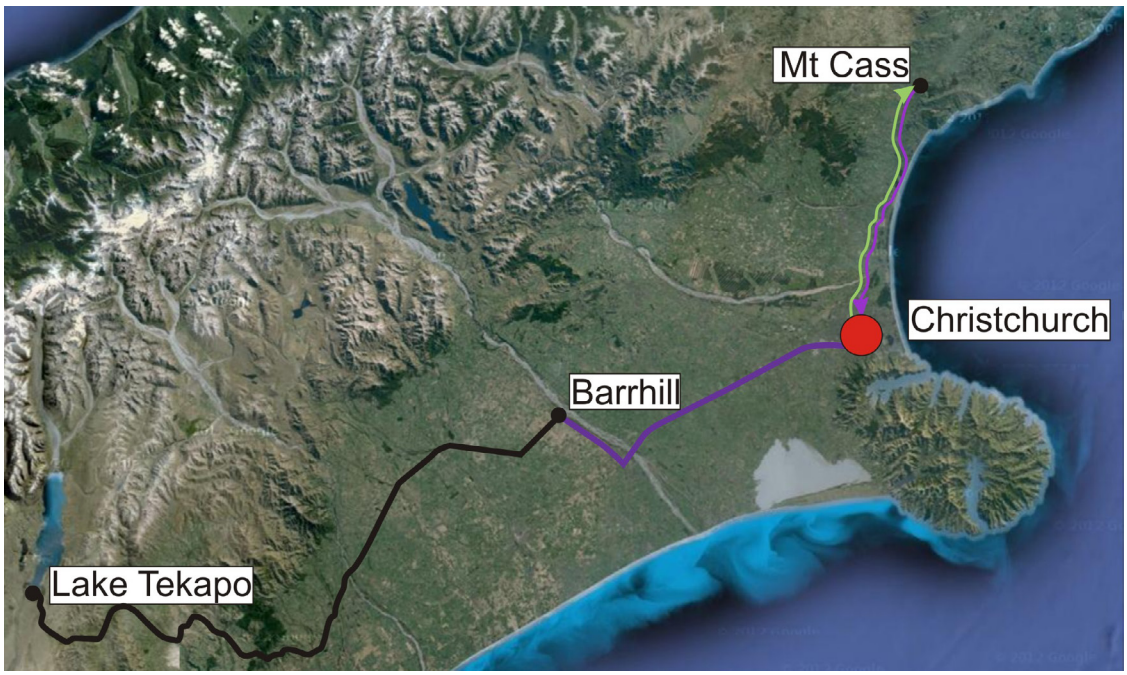

Figure 1. Route map.

our second stop, the Barrhill loess (Figure 1). We were taken to a 4 m thick exposure at Poplar Grove, adjacent to the Rakaia River. It was a beautiful location to stop at (Figure 4). Phillip Tonkin led the description and discussion of this site. The loess section at this site is of Holocene age and overlies late Pleistocene sandy gravel alluvium. The loess is sourced from silts deposited on the large Rakaia floodplain, and loess is still being derived from this source today. Again, we were allowed to explore the section and enjoy the scenery before returning back to the bus to continue our journey.

The final leg of the trip took us across the Canterbury Plains and up into the Mackenzie Basin to our final destination, Lake Tekapo (Figure 1). Throughout our journey, Peter Almond and others provided an interesting commentary about the significant geology and geomorphology of the landscape we were driving through. We arrived at Lake Tekapo around 18:30, just in time for the icebreaker BBQ. The Lions Club were our host for the evening and had decided to entertain us by the water's edge, allowing Lake Tekapo to provide a beautiful backdrop for our BBQ. The food was excellent and everyone took the opportunity to renew old acquaintances and make new ones. After everyone was satifactorily fed the group went to their respective residences to rest, and in some cases prepare, for the conference ahead. The pre-conference fieldtrip provided a perfect introduction to the conference and set the tone for the remainder of the event.

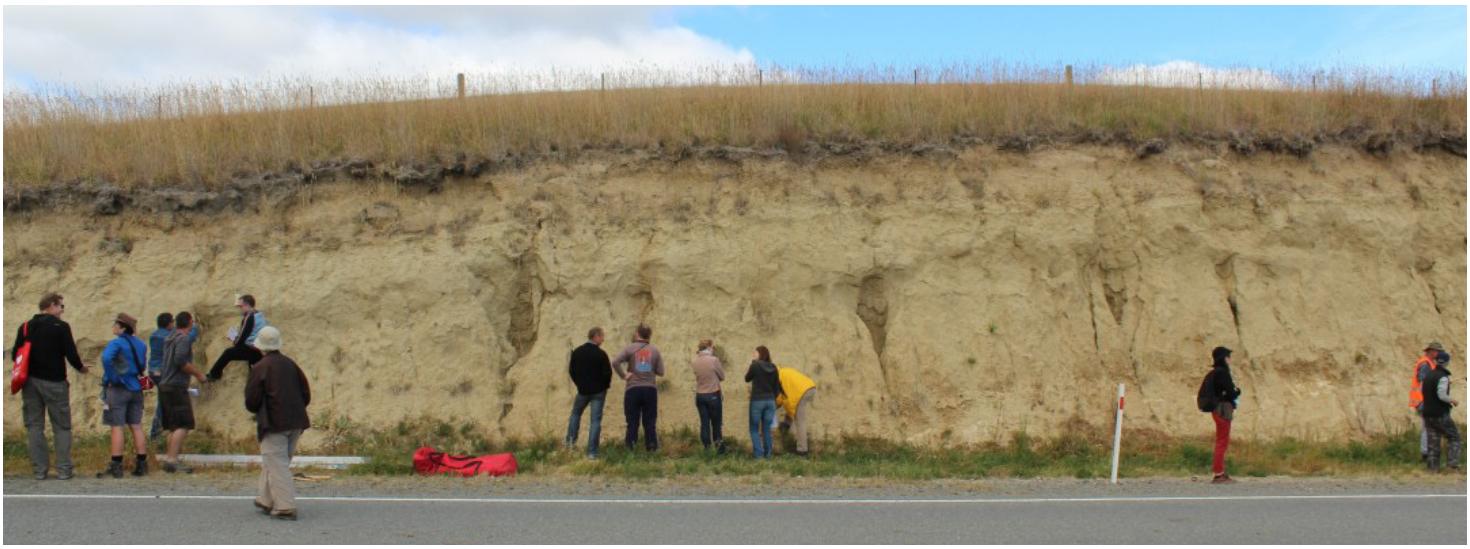

Figure 2. (TOP) Mt Cass loess section (Photo- S McGowen). Figure 3. (ABOVE): Landscapes at Mt Cass.
Figure 4.(BELOW) The Rakaia River next to the Barrhill loess section at Poplar Grove terrace edge (Photo- S McGowen).

New Year in the New Forest

Quaternary Research Association Annual Discussion Meeting Beaulieu Hotel, Hampshire, UK

4-6 January 2012

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Figure 1. Beaulieu Hotel.

When I lived in Britain, I was a member of the Quaternary Research Association (QRA) and regularly attended the Annual Discussion Meetings, which were always informative and entertaining. So, when a visit 'home' coincided with the 2012 meeting, on *Quaternary Science and Society*, I was able to catch up with former colleagues and learn about the currently 'hot' topics in British Quaternary research. The meeting was organised by the Palaeoecology Laboratory at Southampton University, who are to be congratulated for organising a pleasant venue and excellent programme. Beaulieu Hotel is a former coaching inn on the Lymington-Southampton road (Figure 1A). The New Forest, which I had never previously visited, is called 'new' because it is not virgin forest. It was created, by William II Rufus (1087-1100), as a hunting reserve, but the trees are all British endemics. Now, the forest is a National Park, home to deer and a unique breed of ponies (Figure 1B); while residents pasture cows, pigs and sheep on the 'Commons', making driving hazardous.

The summaries of the presentations that follow are based on the points I noted as particularly interesting during each talk, not the printed abstracts.

Topic 1 was Quaternary climate systems. Eelco Rohling (Southampton) focussed on the EPICA dome data for climatic forcing, noting its record 'only' goes back to 520 ka. While Australia does have some long palaeoenvironmental records (Kershaw, 1976; Kershaw *et al.*, 1993; McKenzie, 1997, 2002; Atahan *et al.*, 2004;

Haberle, 2005), they are not continuous and have not been as intensively studied or as comprehensively dated as EPICA. Rohling showed how patchy global palaeoclimatic coverage is, arguing that long records are needed from 'unsexy' areas like the southern Pacific, because events in the polar records (EPICA/NGRIP) are clearly diachronous. Simon Blockley (Royal Holloway) emphasised the need for reliable, independently dated, climatic chronologies. For example, NGRIP has been dated using tephrochronology, Monticchio is varved; making it possible to link events in Greenland with those in Italy, based on the radiometric dates for both records. He argued that a detailed climatic lattice with an uncertainty of $\pm$ 100 years can now be built for northwest Europe from other decadal records. Annual records may soon become possible. We are a long way from having such detailed records in Western Australia in particular, as I showed the QRA in my own presentation which discussed the difficulties of studying the Anthropocene when the Quaternary record is a thin skim over Archaean bedrock. Christine Lane (Oxford) discussed her DPhil research at Haua Fteah, Libya, a deeply-stratified archaeological site originally investigated by Charles McBurney in the 1950s with a record extending back to the Middle Pleistocene. She is studying the cave's tephrochronology, which confirms McBurney's radiocarbon dates back to about 30 ka and suggests that anatomically modern humans (AMH) first appeared at the site about 70 ka. This late date may have implications for the initial human colonisation of Australia, which occurred shortly thereafter. It suggests that AMH may have moved eastwards out of the Horn of Africa across the Arabian Peninsula to India before they were able to penetrate northern Africa (Armitage *et al.*, 2011), the Middle East or Europe; regions already occupied by Neanderthals, who may have been a more successful species than popularly supposed. I have long espoused that view, but had difficulty publishing it because my reviewers disagreed. Paul Langdon (Southampton) discussed Alaskan methane records; while Paul Hughes (Southampton), a PhD student, described a tephrochronology project in Hokkaido.

Topic 2 asked whether past interglacials are analogues for the current warm period. Eric Wolff (British Antarctic Survey) showed that interglacials were much weaker during the early Bruhnes than after 400 ka. While Milankovič basically got it right, Wolff argued that the main drivers of northern hemisphere glaciation are CO_2 levels and summer insolation. Interglacials happen when there is warming, but no Dansgaard-Oerschger event. Bill Gosling (Open University) discussed subtropical pollen records spanning MIS 9-1 from Lake Titicaca, Bolivia/Peru, and MIS 11-1 from Lake Bosumtwi, Ghana. Both cores suggest that MIS 1 is much wetter than MIS 5e was, due to a major climatic shift during MIS 2. Hence, global climatic models cannot assume the present is an analogue for the past and the possibly anthropogenic signal in charcoal records from the Australian subtropics, such as Lynch's Crater and ODP 820 (Kershaw, 1976, 1994; Kershaw *et al.*, 1993; Webb, 1995; Turney *et al.*, 2006), may merit reassessment. The signal may be more climatically-driven than Kershaw originally supposed. Erin McClymont (Durham) discussed the pattern of Milankovič cycles from MIS 35 to present. Ocean cooling really began 1.8 Ma in the far South Atlantic; driven by the Agulhas Current and the closure of the Panama isthmus, not by northern hemisphere ice sheet expansion. Does Australia yield comparable data? From her global diagrams, it would appear Australia does not respond to the same drivers as the South Atlantic. Natasha Barlow (Durham) argued that at 8.4 ka sea-levels around Britain were at +4 m; whereas during MIS 7 they were well below present, partially explaining why there is a plentiful archaeological record from that interglacial; the North Sea land bridge stayed open longer permitting more people to reach Britain. Gareth Tye and Jennifer Sherriff (Royal Holloway) are re-examining the palaeoclimatic record at Marks Tey, Essex, type site for the Hoxnian (MIS 11). Turner (1970, 1975) calculated that this varved pollen sequence covered about 25,000 years from the late Anglian (MIS 12) to the initial Wolstonian (MIS 10). It also records a 350-year, previously 1500-year (Webb, 1990), period of high charcoal and grass pollen that Turner attributed to anthropogenic burning, but that could have had climatic causes. Darren Jeffers (Oxford) is using the magnetic susceptibility of valley sediments as a rainfall proxy in the Beqaa valley, Lebanon. His approach might be applicable to the Australian arid zone where palaeoclimatic data rarely survive. Jonathan Holmes (University College) discussed the non-linearity of North African climatic responses to orbital forcing in the mid-Holocene. These four PhD research presentations were of high quality and concluded an excellent and thought-provoking first day. I was particularly pleased to learn that Haua Fteah, a key North African sequence, and Marks Tey, are being reinvestigated.

Topic 3 was environmental management. Eleanor Brown (Natural England) noted that politicians do not understand the concept of biodiversity, the need for refugia and/or potential sources of ecosystem harm. Jim Rose (Royal Holloway) discussed the economic cost of climate change, the importance of hydrogeology and identifying landscapes needing preservation. Jane Bunting (Hull) discussed the importance of talking to stakeholders about environmental and conservation issues in language they understand. John Stewart (Bournemouth) showed why the Watervole (*Arvicola terrestris*) and Eagle Owl (*Bubo bubo*) merit conservation. These speakers' comments should resonate with AQUAns who have to deal with ill-informed farmers, greenies, pastoralists, politicians and members of the general public about the need to conserve the unspoiled areas of Australia!

Topic 4 was applied Quaternary Science. Harry Langford inveighed against peer-review because it stifles originality. His interpretation of the ice-margin in East Anglia in MIS 8 and MIS 6 was clearly controversial. Clive Auton and Andrew Finlayson (British Geological Survey) demonstrated 3D models that can be 'peeled away' to highlight aspects of surface and subsurface geology. Conservationists, civil engineers and city planners find these models easier to understand than conventional maps. The software might be adaptable to Australian contexts and is freely available from

either caa@bgs.ac.uk or afin@bgs.ac.uk. Natalie Ludgat (Open University) described her PhD research into the sedimentology of two caves in Vietnam. Mary Edwards (Southampton) is using environmental DNA to identify the biota of areas where pollen and bones do not preserve. I shall discuss the possibility of using this technique in Australia with James Haile (ex-Oxford, now Murdoch) since I rarely recover any environmental data from the arid zone sites I investigate.

Topic 5 was human-climate-ecosystem interactions. Andy Dugmore (Edinburgh) argued that Norse settlements in Greenland failed because the settlers could not adapt to changed socio-economic conditions in the 1400s. Marie-José Gaillard-Lemdahl (Linnaeus) described LANDCLIM programs for reconstructing land-use and vegetation cover that are freely available from her. Nicky Whitehouse (Belfast) and Tony Brown (Southampton) discussed aspects of Irish prehistory and Michael Grant (Wessex Archaeology) talked about the New Forest. Rick Battarbee (University College) and Giri Kattel (Ballarat) described indubitable evidence for climate change: ^{15}N depletion in high latitude lake sediments and maar lakes in Germany and New Zealand, respectively. The lag between climate change and biological response can easily be 500 years, which has major implications for some Australian environments. We cannot predict the consequences of the changes we presently observe. For her PhD, Samantha Allcock (Plymouth) is attempting to correlate the environmental signal in varved lake sediments in central Turkey with the regional archaeological record. Ke Zhang (Southampton) described ecologically unsustainable land practices in the Yangtze Basin, which need to be changed. Helen Shaw (Lancaster) also described the difficulties of persuading people to change their ecologically destructive farming practices. Both topics resonated with me now that I mainly work in the rangelands. Hazel Reade's (Cambridge) PhD research on $\delta^{18}O$ in Barbary sheep tooth enamel from Haua Fteah also documents environmental change. Virgil Dragusin (Bucharest) inferred increased human environmental impact in Late Bronze / Early Iron Age Romania from $\delta^{13}C$ in speleothems. Hélène Ducrotoy's (Aberystwyth) PhD researches the domestication of *Sorghum bicolor*, a staple food plant in Ethiopia. Francis Mayle (Edinburgh), his PhD student, John Carson, and Joe Williams (Kansas State) described varied evidence for anthropogenic landscape change in Amazonia.

Before the conference dinner on 5 January, Tom Webb III (Brown) gave the Wiley guest lecture. He showed how *Pollen Viewer*, downloadable from the NOAA website, plots the recolonisation of northeastern North America by thermophilous trees following Laurentide ice retreat and the influence of latitude and altitude on which species flourished where and when. I find this database, and NEOTOMA, useful teaching tools for my high school Geography students, even if the data are North American. AQUAns should know about and may want to contribute data to a new website, CLIMATICA (climatica@gmail.com) that the QRA is developing to deliver 'accessible climate science for everyone'; contact t.p.lane@durham.ac.uk.

Topic 6, the Anthropocene, closed the meeting. Phil Gibbard (Cambridge and Chair of the Subcommission on Quaternary Stratigraphy of IUGS) argued passionately that (a) we are still in the Pleistocene and (b) the term Anthropocene should be suppressed or merely used informally because it has no GSSP. I heartily concur, but fear he is fighting a losing battle, particularly with archaeologists (Webb, n.d.). When I moved to Australia in 1988, I was surprised to find

Figure 2. New Forest ponies.

the term Holocene in use, since in Britain back then we called the present interglacial the Flandrian. The suggestion that the anthropogenically-created climato-environmental changes the world is now experiencing deserve a special stratigraphic label seems to me as misguided as those palaeoanthropologists who give every new hominid find not just a unique species name, which may be justified, but a separate generic name. *Homo sapiens* apparently *needs* to particularise itself. Whereas, if hominid fossils were beetles they would all be in the same species, there is so little formal difference between them, when compared with beetles; as the great entomologist Russell Coope remarked at a QRA meeting many years ago.

Michael Ellis described iARC, an International Anthropocene Research Community, under development by BGS. The aim: to map the spatial effects and temporal limits of the Anthropocene, to determine whether it should be considered a new stage. I would urge AQUAns to join that debate because our environmental and archaeological record is uniquely relevant to the Anthropocene debate. Aboriginal people never developed agriculture and the British arrived when the Industrial Revolution was well underway. Ian Fairchild (Birmingham) argued the detection of ^{137}Cs in speleothems should mark the start of the Anthropocene because the signal is man-made and found worldwide, but the 1950s seem rather too recent a beginning to me. Tony Brown (Southampton) concurred, showing how British landscapes have changed since the introduction of agriculture; while the Industrial Revolution began in the 1500s, even if it culminated in the 1800s. He argued that it is the *duty* of Quaternary scientists to lead discussion on the validity of the term Anthropocene and to define its beginning. The Holocene boundary is now formally set at -1492.45 m in the NGRIP core and dated to 11,703 ± 50 before 2000 AD (Walker *et al.* 2009). Hence, it runs the risk of disappearing as a valid stage if the term Anthropocene is introduced and defined as the global development of agriculture. This began in the Levant about 12,000-11,500 BP and about 10,000 BP in Southeast Asia, China and MesoAmerica (Rindos 1984).

As an aside, Rewi Newnham (Wellington) discussed some of these issues at the recent AQUA meeting at Lake Tekapo; while the Geological Society of London plans to issue a volume on the Anthropocene later this year. I urge those, like me, with strong views on the Anthropocene to contact rewi.newnham@vuw.ac.nz.

A point of personal interest emerged at the QRA meeting: there is still no evidence that people managed to resettle Britain during MIS 5e. A decade ago, I argued that their absence reflected the speed of sea-level rise, which flooded the land bridge before people had spread far enough north in sufficient numbers from their probable refugia in southern Europe during MIS 6 to make migration across the North Sea necessary – there was plenty of empty land in northwest Europe for them to occupy (Webb, 1999). It was satisfying to note that my argument still stands.

Over 100 people attended the QRA meeting, of whom about half were postgraduates or postdoctoral scholars who delivered excellent oral and/or poster presentations; suggesting that the future of Quaternary research in the UK is healthy. The meeting revived my latent envy of the data they have at their disposal (Webb, 1993), the quality of their chronostratigraphic controls, the detail in their palaeoenvironmental records and the apparent ease with which they manage to conduct fieldwork in far-flung corners of the globe. That said, Australian research has its compensations: the excitement of recording baseline data; knowing one is the first person to have consistently studied, and published, the Quaternary evidence from a specific area; and the weather is usually better!

References

- Armitage, S.J., Jasmin, S.A., Marks, A.E. and three others. 2011. The southern route 'Out of Africa': Evidence for an early expansion of modern humans into Arabia. *Science*, 331, 453-6.
- Atahan, P., Dodson, J.R. and Itzstein-Davey, F. 2004. A fine-resolution Pliocene pollen and charcoal record from Yallalie, south-western Australia. *Journal of Biogeography*, 31, 199-205.
- Haberle, S.G. 2005. A 23,000-yr pollen record from Lake euramoo, Wet tropics of NE Queensland, Australia. *Quaternary Research*, 64, 343-356.
- Kershaw, A.P. 1976. A late Pleistocene and Holocene pollen diagram from Lynch's Crater, north-eastern Queensland, Australia. *New Phytologist*, 77, 469-498.
- Kershaw, A.P. 1994. Pleistocene vegetation of the humid tropics of northeastern Queensland. *Palaeogeography, Palaeoclimatology, Palaeoecology*, 109, 399-412.
- Kershaw, A.P., Mackenzie, G.M. and McMinn, A. 1993. Quaternary vegetation history of northeastern Queensland from pollen analysis of ODP site 820. *Proceedings of the Ocean Drilling Program, Scientific Results*, 133, 107-114.
- McKenzie, G.M. 1997. The late Quaternary vegetation history of the south-central highlands of Victoria, Australia. Part I: Sites above 900 m. *Australian Journal of Ecology*, 22, 19-36.
- McKenzie, G.M. 2002. The late Quaternary vegetation history of the south-central highlands of Victoria, Australia. II: Sites below 900 m. *Austral Ecology*, 27, 32-54.
- Rindos, D.J. 1984. *The Origins of Agriculture: an evolutionary perspective*. Academic Press, Orlando.
- Turner, C. 1970. The Middle Pleistocene deposits at Marks Tey, Essex. *Philosophical Transactions of the Royal Society of London*, 257B, 373-440.
- Turner, C. 1975. The correlation and duration of Middle Pleistocene interglacial periods in northwest Europe. In K.W. Butzer and G.Ll. Isaac (eds) *After the Australopithecines*. Mouton, The Hague. 259-308.
- Turney, C.S.M., Kershaw, A.P., James, S. and five others. 2006. Geochemical changes recorded in Lynch's Crater, northeastern Australia over the past 50 ka. *Palaeogeography, Palaeoclimatology, Palaeoecology*, 233, 187-203.
- Walker, M.J., Johnsen, S., Rasmussen, S.O. and 16 others. 2009. Formal definition and dating of the GSSP (Global Stratotype Section and Point) for the base of the Holocene using the Greenland NGRIP ice core, and selected auxiliary records. *Journal of Quaternary Science*, 24, 3-17.
- Webb, R.E. 1990. On mid-Hoxnian deforestation. *Current Anthropology*, 31, 76-77.
- Webb, R.E. 1993. Quaternary research in Western Australia. *Quaternary Newsletter*, 69, 24-33.
- Webb, R.E. 1995. ODP site 820 and the initial human colonisation of Sahul. *Quaternary Australasia*, 13 (1), 13-18.
- Webb, R.E. 1999. The landbridge filter effect and the pattern of colonization of the British Isles by thermophilous terrestrial mammals during the later Pleistocene. *Records of the Western Australian Museum*, Supplement 57, 422.
- Webb, R.E. n.d. Pleistocene, Holocene and/or Anthropocene? Why understanding the Quaternary is important for Australian archaeologists (in preparation).

Associate Professor Jim Peterson (1939-2012)

We were very saddened to hear that James Andrew Peterson, a long standing member of the Australian Quaternary community, died on January 23, 2012, aged 73, about 18 months after being diagnosed with advanced prostate cancer. We were also shocked because we thought Jim was indestructible, having survived a lifetime of geographical and gastronomic adventures. He is survived by his wife Lynette, daughters Carol and Susan, and by a very large number of colleagues, devoted students and friends who are attempting to come to terms with this loss.

Jim was born and brought up in Tasmania, an environment that fostered his spirit of adventure and love of wild places and also, no doubt, other facets of his distinctive personality. He excelled academically, becoming Dux of the Hobart High School graduation class of 1956, despite spending any spare time hiking and roaming around the shores and over the mountains of the island. He was then awarded a Teacher Studentship at the University of Tasmania, and gained his Tasmanian Teaching Certificate as well as a BA (Honours) in 1961. I'm sure no-one will be surprised at the title of his thesis: "The Geomorphology of the Frenchman's Cap National Park, Western Tasmania." After a stint as a Secondary School teacher at New Town Technical High School in Hobart, he undertook an MSc at McGill University in Montreal, Canada, while supporting himself, mainly, as a research assistant at the McGill Sub-Arctic Research Laboratory. His thesis, submitted in 1964, was based on extensive fieldwork within a remote area where two students from the Laboratory had shortly before disappeared, and was entitled "The Whitegull Lake Area, Labrador-Ungava: Studies of the Late Glacial Geomorphology."

Jim then moved to Monash University where he remained for 46 years until his retirement in 2010, only four years short of the 50 year time-span of his host Department of Geography, currently named the School of Geography and Environmental Science. It is very unfortunate that Jim, as the person who has spent the longest time in the Department, cannot be a part of this year's anniversary celebrations. His original position was as Research Scholar supported by a Monash Postgraduate Scholarship. His project, "The cirques of southeastern Australia: Studies on morphology and distribution, history and significance," was initiated under the supervision of glacial geomorphologist Ed Derbyshire, one of several British lecturers in the fledgling Department who wanted a taste of the colonies, and was completed while lecturer (junior lecturer as Jim used to enjoy labelling himself), having replaced Ed after his return to the UK.
With his impressive knowledge and experience of glacial history and landscapes, Jim was able to attract the support necessary to broaden his Australasian interests beyond southeastern Australia to present and past glaciated environments of Papua New Guinea and West Irian. From his work there with colleagues, especially Geoff Hope from the ANU, he produced a number of publications including a book and paper in the prestigious journal *Nature.* He also worked on Macquarie Island, but his major ambition of researching in Antarctica eluded him until a1984/5 field season mapping in the Vestfold Hills, by which time he was largely pursuing other goals. Potential opportunities of local glacial projects that could attract honours and research students were greatly diminished with his publication in 1971 of a seminal paper that resolved, in the negative, past debate over the occurrence of Quaternary glaciation in Victoria.

However, Jim was successful in establishing more general Quaternary studies within the Department. He considered that support from a tame palynologist would be useful and worked on me during his visits to the ANU to attend Quaternary Discussion Group Meetings. He demonstrated his enthusiasm for the Quaternary by travelling overnight to and from Canberra by bus. Although an early return time tended to curtail his participation in post-meeting drinks, this didn't really worry Jim, since alcohol appeared not to agree with him. I was persuaded to apply for an advertised lectureship in "Resource Management." I remonstrated with Jim that I didn't even know what the term meant, to which he responded "neither does anyone else!" Despite concerns expressed by the Human Geography Professors at Monash about the relevance of papers like "Pollen morphological variation in the Casuarinaceae" to any kind of geography, Jim, from his lowly junior lecturer position, convinced the Department to hire me. We set up what we thought was the first Australian undergraduate Quaternary Studies unit in 1975 and this unit has essentially continued, in some form, to the present day. We were also successful in gaining Monash and ARC support for projects. However, through time Jim's role lessened for a number of reasons, including the relative difficulty in designing student geomorphic as opposed to palynological projects, and his preference for study sites in inaccessible places (a preference he appeared to share with Geoff Hope), in contrast to my preference for sites as close to roads and pubs as possible. Jim also was a true geographer, unlike someone who focused on things like Casuarinaceae. Utilising his remarkable knowledge and memory, combined with his ability for lateral thought, was able to successfully supervise honours, masters and master of environmental science students in a remarkable range of discipline areas. These included patterns of possum nuisance, the search for the Mahogany ship, the relocation of the Coode Island chemical storage facility, exotic pollen fallout over Macquarie Island, the analysis

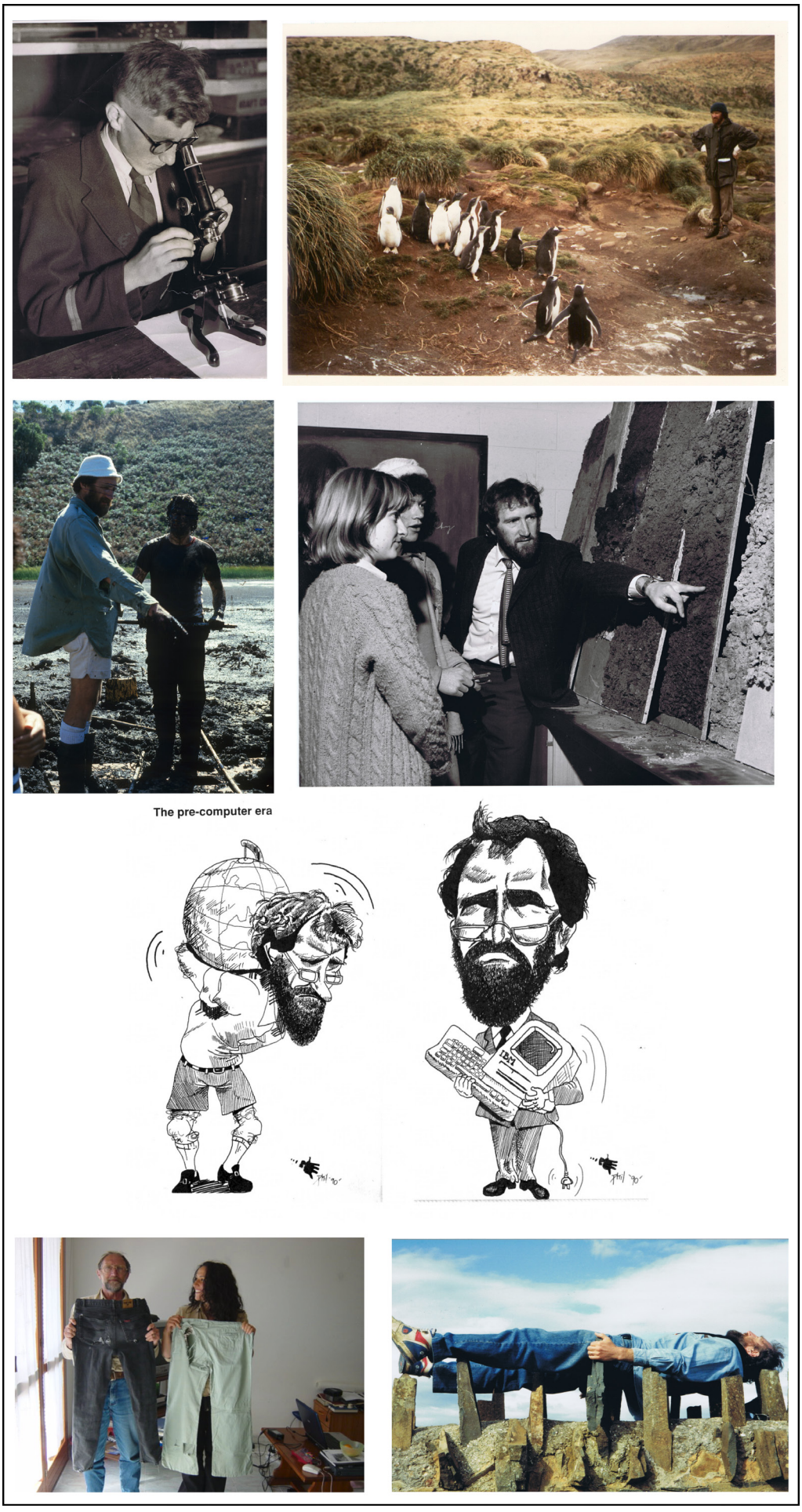

Figure 2. Left to right by row: Pre-Quaternary Jim; One of Jim's more organised lectures –Macquarie Island (Photo: Dave Mercer); The hard task-master in a crater swamp at Tower Hill, 1985. 'Get down that hole again and this time bring up the corer'; People were in awe of Jim's soil peels; Phil Scamp's perception of Jim's transition to GIS; Even in Sardinia, fieldwork can be hazardous; Time for a nap.

of a Pleistocene faunal deposit, alternative approaches to mapping population density in urban areas, the nature of the treeline on Mt Buller, bushwalking and camping impacts, septic tank siting, tourism in the Antarctic, distribution of golf courses, weed mapping, fuzzy set theory, interpretation of Minoan landscapes, and feral rabbits! Jim also maintained a strong interest in education, exemplified by his acquisition of a Diploma in Tertiary Education, long term involvement in Victorian Secondary School geography curricula, and delivery of over 25 different undergraduate and graduate units. He was a Monash pioneer in teaching innovations, including flexible mode delivery and production of teaching videos.His teaching style was so advanced that many had difficulty in comprehending it.

Over the years, Jim became increasingly concerned that Geographical Information Systems – considered the future of the Discipline - was not being addressed by the Department and eventually, having failed to convince those more numerically and technically minded to get involved, did so himself. The development of GIS might have been more rapid with financial and technical resources, and using a system with instructions in English rather than German. Nevertheless it survived and eventually prospered. Jim attracted a range of students with technical skills, many from overseas, who appreciated his "Science behind the Theme" approach. He became Foundation Director of the Centre for Geographical Information Systems at Monash University in 1991.

One perception of how GIS changed Jim is provided by the 1990 cartoon produced by Phil Scamp, long time draftsperson in the Department who himself became the Baptist Minister who officiated at Jim's Memorial Service. A more tangible indication of Jim's transition from the Quaternary to GIS is demonstrated by the drop off in Quaternary-related publications after 1988, as indicated in the Appendix. This, however, was more than compensated by the rise in GIS publications, a result of Jim's very positive response to a general university request for increased productivity. Jim also achieved his only PhD student completions in GIS – a remarkable total of ten in the last few years, with the latest submitted just days after his death.

Perhaps the most balanced and satisfying recent pursuits were in the Mediterranean, where a mixture of his major teaching and research areas – Quaternary studies, volcanics, coastal landforms and GIS - were combined with classical archaeology to provide an ideal environment for combining fieldwork and pleasure for Jim and Lynette, courtesy of Lucia Lancellotti, and in East Gippsland where, with Peter Wheeler, coastal landscapes, human activities and GIS led to effective future coastal management planning. Similar proposals in Southeast Asia and China, the sources of many research students, were being developed.

Clearly Jim achieved a great deal in his life, but to many, especially administrators, this was unexpected. Jim could frustrate by not being on the same wavelength or timescale as others. Equally frustrating could be his apparent interest in the system expressed in the form of long monologues in staff meetings and frequent memos to Heads of Department. Whatever Jim's intentions, the results were generally positive for his research and teaching interests! He was seldom asked to undertake administrative tasks or interrogated about what he was actually doing.

Since Jim was generally considered much more interesting and endearing than anyone else, he was made the subject of the one and only Toast and Roast held by the Department. This was back in 1989 around the time of his academic transition. Perhaps an overview of Jim's actual and, at that time, anticipated activities can be best gained from the following song, written for his roasting (with apologies to Bob Dylan).

Jim minus zero – no limit

Where has he been, our blue-eyed Jim
Where has he been, our adventurous one
He's been 10,000 miles chasing the Tasmanian Tiger
He's been 200 miles on a 6 mile excursion
He's jogged along beaches with a rucksack full of sand
He's walked and he's crawled over 11 hundred glaciers
He's meandered along highways and raced along cart tracks
Chorus: He's a hard, he's a hard, he's a hard, and he's a hard, he's a hard man is our Jim
And what has he done, our blue-eyed Jim
And what has he done, our adventurous one
He's discovered 50 bogs in inaccessible places
He's measured and sounded 600 lake basins
He's had frostbite on Macquarie and got scurvy on oatmeal
He's had 500 hangovers on 2 halves of shandy
He's drunk 8000 jugs of best staff club water
He's led 24 people on a Carstensz expedition
He's led 11 people back from a Carstensz expedition
And who has he talked to, our blue-eyed Jim
And who has he talked to, our adventurous one
He's talked to 400 people on an early morning jog
He's talked to 800 students on a walk across campus
He's talked to 2 million people on the end of a mouthpiece
He's talked to mud men, spear men, Eskimos and penguins
He talked to his next door neighbour while he bulldozed Jim's house
And what will he do now, our blue-eyed Jim
And what will he do now, our adventurous one
He's going to sit at his computer and try not to break it
He's going to learn German so he might be able to work it
And he's going back out before the ice starts a'melting
Before the Greenhouse effect has destroyed his research field
He'll bring all the ice back and put it into his freezer
So the ice age remains in the Peterson household
To work on in retirement in between writing memos
And he'll reflect on the meaning of environmental stability

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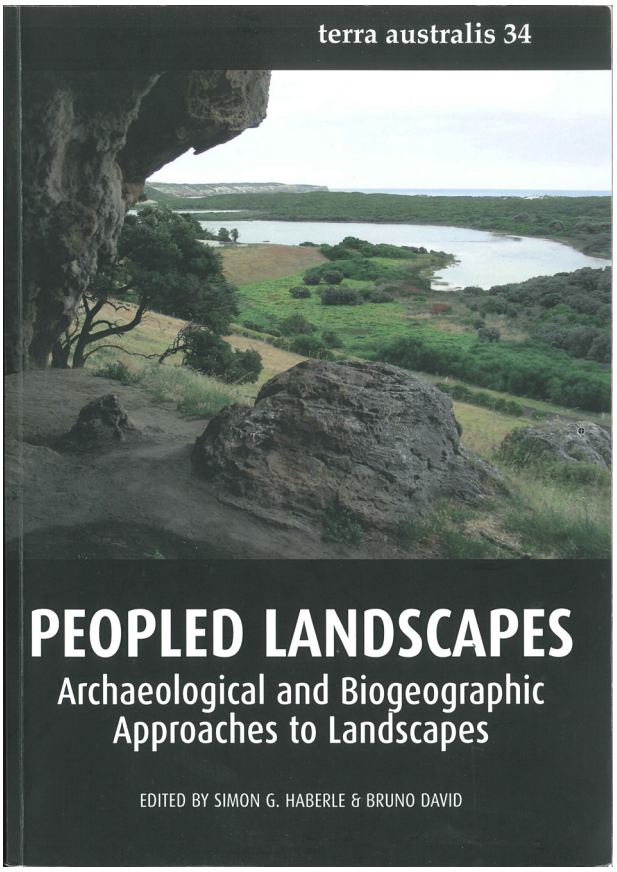
Appendix: Quaternary-related publications

- Prentice, M.L., Hope, G.S., Maryunani, K. and Peterson. J.A., 2005. An evaluation of snowline data across New Guinea during the last major glaciation, and area-based glacier snowlines in the Mt. Jaya region of Papua, Indonesia, during the Last Glacial Maximum. *Quaternary International,* 138-139, 93-117.
- Peterson, J.A., Chandra, S. and Lundberg, C. 2004. Landforms from the Quaternary glaciation of Papua New Guinea: an overview of ice extent during the Late Glacial Maximum. In J. Ehlers and P.L. Gibbard (Editors) *Quaternary Glaciations - Extent and Chronology, Part III: South America, Asia, Africa, Australia, Antarctica*. Elsevier, Amsterdam. 313-319.
- Peterson, J.A., Hope, G.S., Prentice, M., and Hantoro, W., 2002. Mountain Environments in New Guinea, and the late Glacial maximum "warm seas/cold mountains" enigma in the West Pacific Warm Pool region. In A.P. Kershaw, B. David, N.J. Tapper, D. Penny, and J. Brown (Editors) *Bridging Wallace's Line. Advances in Geoecology,* 34, 173-187.
- Galloway, R.W., Kiernan, K., and Peterson, J.A., 1998. Effects of snow on the landscape, In K. Green (Editor). *Snow: a natural history; and uncertain future*. Australian Alps Liaison Committee, Canberra. 69-80.
- Stone, J., Peterson, J.A., Fifield, L.K. and Creswell, R.G., 1997. Cosmogenic chlorine-36 exposure ages for two basalt flows in the newer volcanics province, Western Victoria. *Proceedings Royal Society of Victoria*, 109 (2), 121-131.
- Peterson, J.A., 1996. Latex Peels: overcoming the problem of blocked spray nozzles. *Quaternary Australasia,* 14 (1), 40-41.
- Peterson, J.A. and Peterson, L.F., 1994. Ice retreat from the neoglacial maxima in the Puncak Jayakesuma, Republic of Indonesia. *Zeitschrift fur Gletscherkunde und Glazialgeologie*, 30(1), 1-9.
- Zhou, L., Williams, M.A.J. and Peterson, J.A., 1994. Late Quaternary aeolianites, palaeosols, and depositional environments on the Nepean Peninsula, Victoria, Australia. *Quaternary Science Reviews*, 13(3), 225-239.
- Zhou, L., Feng, S., Williams M.A.J. and Peterson J.A., 1994. A Preliminary Stratigraphic Interpretation of Palaeosols Sections from Nepean Peninsula, Victoria, Australia. *Journal of Desert Research*, 14(1):38-45.
- Zhou, L., Williams, M.A.J. and Peterson, J.A., 1993. Surface microtexture study of late Quaternary aeolianite by scanning electron microscopy and its implication for reconstructing the sedimentary environment: A case study from Fingal Beach Coast Cliff Section, Cape Schanck, Victoria. *Quaternary Australasia,* 10(1), 13-26.
- Peterson, J.A., Finlayson, B.L., Zhang, Q., 1988. Evolution of terrestrial and lacustrine environments of the Vestfold Hills, Antarctica: an interpretation from current data on deglaciation and emergence. *Hydrobiologia* , 34, 221-226.
- Peterson, J.A. and Scott J.J.,1988. Interrelationships between wind exposure, vegetation distribution and pollen fallout between Bauer Bay and Sandy Bay, Macquarie Island. *Papers, Royal Society of Tasmania*, 122 (1), 247-253.
- Peterson, J.A. and Mercer, D.C., 1988. Australia and the 'Greenhouse Effect': the Science Policy debate. In G. Pearman (Editor). *Proceedings of the CSIRO Greenhouse Conference, Monash University, 1987*, AAS and CUP, Canberra and Melbourne. 708-724.
- Colhoun, E.A. and Peterson, J. A., 1986. Quaternary landscape evolution and the cryosphere: research progress from Sahul to Australian Antarctica. *Australian Geographical Studies*, 24, 145-167.
- Goodman, A. and Peterson, J.A., 1985. Morphometric classification and estimates of lake-bottom dynamics for some major Tasmanian water storages. *Bull. Limnol. Soc. Aust*., 10, 3-13.
- Burns, F., Moresby, J.F. and Peterson, J.A., 1985. The floating islands of Pirron Yallock, Victoria. *Bull. Limnol. Soc. Aust*., 10, 15-32.
- Edney, P., Kershaw, A.P., Coutts, P.J.F., and Peterson, J.A .,1984. Evidence of a Pleistocene age for Tower Hill, Western Victoria. *Search*, 16, 302-303.
- Zhang, Q. and Peterson, J. A., 1984. A geomorphology and Late Quaternary geology of the Vestfold Hills, Antarctica. *ANARE Reports*, 133, AGPS, Canberra.
- Peterson, J.A., Scott, J.J. and Derbyshire, E., 1983. Sorted stripes of periglacial origin. *Australian Geographer* , 15(5), 325-328.
- Peterson, J.A. and Missen, J.E., 1880. Morphometric Analysis of Tasmanian Freshwater Bodies. *Aust. Soc. Limnology Spec. Pub*., 4, 116 pp.
- Peterson, J.A. and Moresby, J.F., 1979. Subglacial travertine and associated deposits in the Carstensz Area. Irian Jaya, Republic of Indonesia. *Zeit. für Glet. und Glazialgeol*., 5(1), 23-29.
- Pittock, A.B., Peterson, J.A. and others, 1978. *Climatic Change and Variability*. Cambridge University Press, London. 455pp.
- Martin H.A. and Peterson, J.A., 1978. Eustatic sea level changes and environmental gradients, In A.B. Pittock, J.A. Peterson. and others, (Editors). *Climatic Change and Variability*. Cambridge University Press, London. 108-124.
- Derbyshire, E. and Peterson, J. A., 1978. A photo-geomorphic map of the Mt. Menzies nunatak, Prince Charles Mountains, Australian Antarctic Territory. *Zeit. für Glet. und Glazialgeol.,* 14(1), 17-26.
- Derbyshire, E. and Peterson, J.A., 1977. Nivation Cirque: Australian landform example 31. *Australian Geographer*, 13, 416-419.
- Hope, G.S., Peterson, J.A. and others., 1976. *The Equatorial Glaciers of New Guinea*. Balkema, Rotterdam. 244 pp.
- Peterson, J.A., 1976. The Lakes. In G.S. Hope, J.A. Peterson and others (Editors). *The Equatorial Glaciers of New Guinea.* 93-112.
- Hope, G.S. and Peterson, J.A., 1976. Palaeoenvironments. In G.S. Hope, J.A. Peterson and others (Editors). *The Equatorial Glaciers of New Guinea*. Balkema, Rotterdam. 173-205.
- Allison, I., and Peterson, J.A., 1976. Ice Areas on Mt. Jaya: their extent and recent history. In G.S. Hope, J.A. Peterson and others (Editors). *The Equatorial Glaciers of New Guinea*. Balkema, Rotterdam. 27-38.
- Peterson, J.A., 1975. The morphology of Major Lake, Macquarie Island. *Aust. Soc. Limnol. Bull.,* 6. 17-26.

- Macphail, M.K. and Peterson, J.A., 1975. New deglaciation dates from Tasmania. *Search,* 6(4), 127-130.
- Hope, G.S. and Peterson, J.A., 1975. Glaciation and Vegetation in the High New Guinea Mountains. *Bull. Roy. Soc. N.Z.*, 13, 155-162.
- Galloway, R.W., Hope G.S., Loffler, E. and Peterson, J.A., 1973. Late Quaternary Glaciation and periglacial phenomena in Australia and New Guinea, In E. van Zinderen Bakker (Editor). *Palaeoecology of Africa 8*. Balkema, Cape Town. 125-138.
- Peterson, J.A., Hope, G.S. and Mitton, R.D.,1973. Recession of the ice fields of Irian Jaya. *Zeit. fur Glet. und Glazialgeol*. 9, 73-87.
- Hope G.S. and Peterson, J.A., 1972. Lower Limit and Maximum Age for the Last Major Advance of the Carstensz Glaciers, West Irian. *Nature,* 240 (5375), 36-37.
- Peterson, J.A., 1971. The equivocal extent of glaciation in the Southeastern Uplands of Australia. *Proc. Roy. Soc. Vict*., 84(2), 207-212.
- Derbyshire, E. and Peterson, J.A., 1971. On the Status and Correlation of Pleistocene Glacial Episodes in South-Eastern Australia. *Search* 2 (8), 285-288.
- Robinson, G., Peterson, J.A. and Anderson, F.M., 1971. Trend Surface Analysis of Corrie Altitudes in Scotland. *Scot. Geog. Mag*., 87(2), 142-146.
- Bayly, I.A.E., Peterson, J. A., and St. John, V.P., 1970. Notes on Lake Kutubu, Southern Highlands of the Territory of Papua and New Guinea. *Aust. Limnol. Soc. Bull*., 3, 40-47.
- Peterson, J.A. and Robinson G., 1969. Partial Trend Surface Mapping of Cirque Floor Levels. *Nature*, 222 (5188), 75-76.
- Peterson, J.A., 1968. Cirque morphology and Pleistocene ice formation conditions in southeastern Australia. *Australian Geographical Studies*, 6, 67-83.
- Barnett, D.M. and Peterson, J.A., 1968. Comments on "Sur le lieu de fonte sur place de la calotte glaciers de Scheffer". *Canadian Geographer*, XII (1), 53-54.
- Barnett, D.M. and Peterson, J.A., 1968. Glacial Lake Naskaupi 2. *McGill Sub-Arctic Memorial Volume*, McGill University, Montreal, 148-159.
- Peterson, J.A., 1966. Glaciation of the Frenchman's Cap National Park. *Papers and Proceedings of the Royal Society of Tasmania*, 100, 117-129.
- Peterson, J.A., 1965. Deglaciation of the Whitegull Lake area, Labrador-Ungava. *Cahiers de Geog. de Quebec*, 9 (18), 183-196.
- Peterson, J.A., 1965. Ice-push ramparts in the George River Basin Labrador-Ungava. *Arctic*, 18 (3), 189-193.
- Peterson, J.A., 1964. Preliminary report on an instrument designed for the study of frost-heave in the Sub-Arctic. *McGill Sub-Arctic Research Papers*, 15, 129-136.
- Barnett, D.M. and Peterson, J.A., 1964. The Significance of Glacial Lake Naskaupi 2 in the Deglaciation of Labrador-Ungava. *Canadian Geographer*, VIII (4), 173-81.



Peopled Landscapes: Archaeological and Biogeographic Approaches to Landscape.

Simon G. Haberle and Bruno David (Editors)
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This *festschrift* for Peter Kershaw comprises an opening appreciation of his contribution to Quaternary Science by the editors and Donald Walker, followed by 22 papers of very varied length, mostly multi-authored, nine of which discuss archaeology and/or landscape and 13 consider biogeographical and/or palaeoecological topics. Several of the archaeological papers are effectively excavation reports, which are difficult to publish in conventional journals. The subjects addressed reflect Peter's eclectic approach to the past. His publications run to 12 closely-typed pages and cover: human visibility; using pollen sequences to infer landscape history; dating successive glacial-interglacial cycles and showing that each was vegetationally unique; novel approaches to palaeoenvironmental reconstruction; deep-time biogeography, particularly of the Araucariaeae; cross-disciplinary research and multi-proxy evidence for past climatic change.

Reflecting the ARC's prejudice against funding archaeological research in Australia, only four papers discuss the mainland record: Hay Cave in the Mitchell-Palmer limestone belt, far north Queensland, yielded a 30,000-year cultural sequence with a zone of inverted 14C dates 15,000-3000 BP (Lourandos *et al.*). As at other Holocene sites, this inversion is attributed to increased rainfall causing down-profile migration of fines. Dating of four of the rock art motifs suggests that painting began after 2000 BP. Richards investigated several shell middens on a cliff top at Cape Duquesne, Victoria, that even at 10,500-10,000 cal BP would have been only 1 km from the Southern Ocean. *Turbo undulata*, *Donax deltoides* and *Paphes angusta* were targeted; other species collected only incidentally. He concludes that these early Holocene sites show no evidence of cultural complexity; whereas by the late Holocene littoral usage was tightly focused on *r*-selected shellfish. Ferrier and Cosgrove argue that ENSO-driven Aboriginal use of toxic yellow or black walnuts on the Atherton Tableland after 2000 BP helped create the complex semi-sedentary tropical rainforest societies recorded ethnographically. Macphail *et al.* show that the presence of *Cloacasporites sydneyensis* on historic sites can, like *Rattus exulans*, indicate human activity when there is no archaeological evidence for people. They suggest *C. sydneyensis* is a commensal introduced into the Pacific accidentally.

The remaining archaeological papers discuss extra-Australia topics: McNiven *et al.* argue that human-environment relationships can be studied archaeologically as well as palynologically. For example, Lapita maritime specialists in southern Papua began causing erosion by burning and clearing 1000 years earlier than previously assumed. At Otoia, a village on Goaribari, an island off the south coast of Papua New Guinea, Barker *et al.* argue that the rise to dominance 500-450 BP of the Kerewo, head hunters who controlled their hinterland resource base through fear, coincided with an increase in traded ceramics that changed the cultural landscape. Dodson *et al.* argue from two female 4000 BP Mongoloid skulls with severe dental disease, from Huoshiliang, that Mongoloids and Caucasoids co-existed then in Gansu province. Millet, a C4 plant, was the dietary staple, but these women ate little protein, although sheep were kept. Head and Regnéll describe 'contested landscapes' in Skåne, the most densely populated part of Sweden with a long history of settlement and landscape management. Now, 'natural' and 'cultural' managers doubt that woods and forests are human constructs; unlike meadows and grasslands.

Finally, Kull and Rangan argue that molecular systematics skewed scientific process in the 'chauvinistic' 2005 ICBN decision to restrict the genus name *Acacia* to Australia, whereas the species known in Africa, the Americas and Asia are more numerous and have taxonomic precedence. Clearly, passions run high when 'iconic' species are involved!

The biogeographic and palaeoecological papers are equally diverse. All but one discuss Australian evidence and most include pollen diagrams. The treeline in Cropp Valley, in the Southern Alps of New Zealand, lacks *Nothofagus* (McGlone and Basher). Elsewhere, it characterises the treeline, which was lower in both

New Zealand and Australia before 11,500 cal BP. After 7000 cal BP, seasonality increased: summers were warmer, winters cooler. Ledru and Stevenson show that *Araucaria* spp. increase during MIS 4 at Lynch's Crater, ODP 820, Lake Xere Wapo, New Caledonia, and Colônia Crater, Brazil, was climatically driven; whereas Kershaw (1986) argued this change was anthropogenic at Lynch's Crater. *Araucaria* declined after 45,000 BP as winters became drier. Bowler *et al*. revise the environmental history of the Willandra Lakes. Mulurulu is now subsumed into Zanci; Arumpo and Mungo remain unchanged. They conclude that considerable volumes of water flowed through the lake system during the LGM, but distal dunes were reactivated. People responded by migrating upstream and exploiting the fish and shellfish left stranded by increasing aridity. The spectacled flying fox (*Pteropus conspillatus*) is a rainforest species found in far north Queensland and Papua New Guinea. Fox *et al*. suggest that catastrophic climatic events may have facilitated gene flow between the two closely-related populations, despite the distances involved, although volant species are less susceptible to habitat change than terrestrial species.

The remaining papers can be grouped regionally: Tasmania, the Top End, Victoria and colonial catastrophes. Parasitism has a long botanic history. *Loranthaceae*-type pollen (mistletoe family) has been recovered from 24 sites in Tasmania and Bass Strait, but none postdates the mid-Pleistocene, although it is still widespread in mainland Australia. Macphail *et al*. attribute mistletoe's extinction in Tasmania to the coolness and wetness of later Pleistocene climates. Colhoun and Shimeld discuss pollen data from 52 late Quaternary sites that give Tasmania a most detailed palaeoenvironmental record. Most changes were climatically driven, but Aboriginal use of fire after 35,000 BP formed 'disclimax' communities, particularly in the southwest where human maintenance of moorland prevented the spread of *Nothofagus*.

Moss *et al*. discuss possible human impact on Wet Tropic sclerophyll woodland at Witherspoon Swamp, northeastern Queensland, in the Holocene. The region is highly sensitive to ENSO, so disentangling anthropogenic and climatic effects is very difficult. ENSO was intense 2500-1700 cal BP, facilitating the development of a rainforest culture based on toxic nuts (Ferrier and Cosgrove, this volume). Rowe studied surface pollen samples from Mua and Badu Islands, in the Torres Strait, as a guide to north Australian vegetation. Monsoonal communities can be characterised and differentiated on their pollen; helping to determine the taxa that facilitate vegetation discrimination outside the wet tropics, where pollen does not preserve well, as I know to my cost. The aerobic sediment in my semi-arid zone sites never yields identifiable pollen.

Tibby *et al*. use the inferred climatic record at Lake Purrumbete to determine how many of the Ramsar-listed lakes in western Victoria will survive the desiccation predicted to occur this century. Purrumbete appears to be fairly resilient to climate shifts, but its nutrient status needs to be monitored to assess deterioration. In the Victorian Central Highlands, cool temperate rainforest interdigitates with *Eucalyptus* forest. Before 2009, it was assumed that during warmer drier periods, when fires are more frequent, supposedly fire-resilient sclerophyllous trees increased; during cooler wetter periods supposedly fire-sensitive rainforest expanded. The Kilmore-Murrindindi fires showed this paradigm to be inaccurate. Rainforest species, particularly *Nothofagus cunninghamii*, survived; *E. regnans* did not (Baker *et al*.).

Denham *et al*. discuss the catastrophic impact of European settlement, and ground clearance for agriculture, on the Aboriginal landscape of the Willunga Plains, South Australia. They demonstrate the utility and robusticity of paired pollen-phytolith analyses for short-term and long-term environmental reconstruction. Turney shows that $\delta^{13}C$ in charcoal in sedimentary sequences measures annual precipitation changes over time and space, permitting assessment of the critical effect of increasing temperatures and declining rainfall in Australia, an arid country with no long historic climate records. For example, Perth already experiences water and power shortages that will only get worse with population increase. Gell illustrates how understanding palaeoecology can facilitate the management of Australia's wetlands, which are now degraded and over-stressed, some beyond repair. Deterioration began at colonisation. Applied ecology was never Peter Kershaw's main interest, but data he and his students accumulated underlie many managerial assessments.

As expected, none of the papers in this excellent volume mentioned Western Australia, but then the Quaternary record of my adopted home state is rarely studied and poorly understood. Nonetheless, *TA34* is full of good things and well worth the purchase price. I shall find the detailed lists of previously unpublished radiometric dates particularly useful. Overall, this massive volume (the spine is 32 mm wide and it weighs 1.5 kg!) is well produced, but some papers were insufficiently carefully proof-read. They include annoying typographical errors or misspellings, and line justification breaks down occasionally. Nonetheless, TA34 is a visible testament to the respect, admiration and affection with which Peter Kershaw is regarded by everyone with any interest in the palaeoenvironment; as the summaries of the individual chapters show, I hope. While the volume has no index, the electronic version, downloadable from http://epress.anu.edu.au, is searchable.

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The Last Glacial Maximum and Deglaciation in Southern New Zealand: New Pollen-climate Reconstructions

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The project builds upon existing knowledge of late Quaternary palaeoenvironmental change and tests the recently developed New Zealand INTIMATE (**Int**egration of **I**ce **Ma**rine and **Te**rrestrial archive) climate event stratigraphy (NZ-I CES; 30-8 ka). Four pollen and sediment records from three climatically contrasting regions in the South Island provide a vegetation and climate history for this area between 38-4 ka. In this study, the Last Glacial Cold Period (LGCP; c. 31.4-18.9 ka) is characterised by a two step cooling, with the coldest conditions, reaching possibly >5.3 °C cooling, occurring between 21-19 ka, marking the Last Glacial Maximum. A new precipitation proxy using macrophyte pollen concentrations at an eastern South Island site suggests dominantly dry conditions prevailed during the LGCP except for two periods of wetter climate around 26-24 ka and 21 ka. The dry periods correspond with evidence of glacial advance, colder environments and possibly increased intensity of the southern westerlies. Conversely, the wet periods coincide with reduced glacial activity, milder climates and decreased westerly wind intensity. Deglaciation began between 18.9-18.4 ka followed by rapid climate amelioration culminating with *Dacrydium cuppressinum*-dominant lowland forest at western sites as early as 11.9 ka, indicative of the start of the Holocene. A disturbance in forest development occurs between 13.4-11.9 ka in one record and may be indicative of a minor cooling within the timeframe of a late glacial climate reversal recognised in the NZI-CES.

Overall the project results (timing and pattern of climate change) broadly align with the NZ-I CES. However, there are some disparities, in particular during the LGCP, which this study suggests began at least 3-4 ka earlier than concluded in the NZ-I CES. The NZ-I CES oversimplifies the complexity of the LGCP which contains evidence of significant climate variability that may be important for an understanding of the possible forcing factors on climate change. The chronology derived from the current study supports recent evidence that points towards a younger, refined age of 25.4 ka for the Kawakawa/Oruanui Tephra, a key chronostratigraphic marker for the LGCP. Pollen-climate models and Environmental Lapse Rates were used to quantify changes in mean annual temperatures with sometimes conflicting results. This research reveals some limitations of the current New Zealand pollen-climate transfer function when applied to reconstruction of cold climate periods in particular. These include a lack of limitations with modern analogues and a number of wide-ranging pollen taxa that encompass a broad climate envelope. The current research also highlights the potential of regional climate regimes and spatial differences in vegetation and inferred climate reconstructions. These differences pose a major limitation for a New Zealand-wide composite. While the NZ-I CES provides a valuable framework of climate change during a period of large climate variability, results of this study highlight aspects that need further consideration and revision.

High resolution ice core records of climate variability and forcing

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This thesis exploits the high temporal resolution and precise dating of ice cores from Law Dome, coastal East Antarctica, to address questions concerning climate forcings, variability and feedbacks over a range of timescales: (i) sub-annual to decadal-scale environmental influences on the ^{10}Be solar activity proxy; (ii) centennial to millennial-scale internal climate variability; and (iii) the phase relationship between Antarctic temperature and atmospheric CO_2 during the last deglaciation.

Cosmogenic ^{10}Be is a primary ice core proxy for past solar activity. However, interpretation of the ^{10}Be record is hindered by limited understanding of the physical processes governing its atmospheric transport and deposition to the ice sheets. The thesis presents a suite of monthly to annually-resolved Law Dome ^{10}Be records, which combined span 1936—2009. The records are quantitatively assessed against observed cosmic ray intensities, instrumental and reanalysis climate data and ECHAM5-HAM General Circulation Model (GCM) simulations. The seasonal variability in ^{10}Be is characterised by an (austral) summer to autumn concentration maximum and a winter concentration minimum. The GCM simulations, corroborated by earlier observations of ^{10}Be:^{7}Be ratios, link the seasonal concentration maximum to direct input of ^{10}Be from the Antarctic stratosphere to the lower levels of the Antarctic troposphere. On annual timescales, Law Dome ^{10}Be concentrations are significantly correlated to the 11-year solar cycle modulation of cosmic ray intensity, $r_{xy} = 0.54$, with 95% confidence interval (CI) [0.31; 0.70]. A significant correlation is also observed between annual ^{10}Be concentrations and the zonal wave three pattern of atmospheric circulation, $r_{xy} = 0.36$, 95% CI [0.57;0.10]. An additional annually resolved ^{10}Be record, from the Das2 site in southeast Greenland spanning 1936—2002, is analysed to facilitate inter-hemispheric comparisons. Das2 ^{10}Be concentrations are also significantly correlated to cosmic ray intensity, $r_{xy} = 0.45$, 95% CI [0.22; 0.62] and to variability in the dominant mode of atmospheric circulation in the region, the North Atlantic Oscillation, $r_{xy} = 0.42$, 95% CI [0.64;0.15]. The strength and spectral coherence of the solar activity signal in ^{10}Be is enhanced, and the climate signals are reduced, when ^{10}Be records are combined from both Antarctica and Greenland. This implies that solar reconstructions are likely to be more robust when ^{10}Be records are included from multiple sites. The amplitudes of the 11-year solar cycles in the ^{10}Be records are inconsistent with the view that the ice sheets receive only ^{10}Be produced at polar latitudes, instead supporting that they sample from a globally well-mixed atmosphere. In addition, a chemical method is developed to remove the problematic ^{10}Be isobar boron-10 from Accelerator Mass Spectrometer (AMS) targets.

The last deglaciation was characterised by a ` bipolar seesaw' pattern of opposing hemispheric climate variations on millennial timescales. Precise information on the timing and sequence of these climate variations can assist in identifying the mechanisms involved. The timescale of the Law Dome ice core is synchronised throughout the deglaciation (using methane ties) with four other high-resolution Antarctic and Greenland cores. The stable water isotope signal in a composite record constructed from the synchronised Antarctic cores is interpreted as a temperature proxy for the Antarctic region. The millennial warming (and cooling) trends in the Antarctic record are matched by opposing cold (and warm) periods in Greenland. There is little-to-no time lag between climate transitions in Greenland and opposing changes in Antarctica. Such rapid signal-communication between the hemispheres supports the operation of rapid bipolar ocean and/or atmospheric teleconnections.

Two precisely dated ice core CO_2 records are synchronised to the same timescale as the Antarctic temperature proxy. These records show that the deglacial CO_2 increase lagged the Antarctic temperature increase by only 0 to 400 years. This implies a faster feedback between temperature and CO_2 than the centennial to millennial-scale lags suggested by previous studies.

Rock Avalanches on Glaciers: Processes and Implications

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This thesis examines the role of rock avalanches in tectonically active terrains including the effects of the deposits on glacier behaviour and their contribution to moraine formation. The chronologies of mountain glacier fluctuations, based on moraine ages, are widely used to infer regional climate change and are often correlated globally. In actively uplifting mountain ranges rock avalanches that travel onto the ablation zone of a glacier can reduce ice-surface melting by insulating the ice. This can cause buried ice to thicken due to slower ablation and can significantly alter the overall glacier mass balance. This glacier response to supraglacial rock avalanche deposits can confound apparent climatic signals extracted from moraine chronologies. This thesis investigates the processes through which rock avalanche deposits may affect glaciers and develops a new technique to identify the presence of rock avalanche debris in glacial moraines.

From laboratory experiments on the effects of debris on ice ablation it is demonstrated that the rate of underlying ice ablation is controlled by diurnal cyclicity and is amplified at high altitude and in lower latitudes. The relatively low permeability of rock avalanche sediment in comparison with non-rock avalanche supraglacial debris cover contributes to the suppression of ablation, at least partly because it greatly reduces the advection of heat from rain water to the underlying ice.

The laboratory findings are supplemented by field investigations of two recent rock avalanche deposits on glaciers in the Southern Alps of New Zealand. This work demonstrates that the rock avalanche deposits are very thick (10 m at Aoraki/Mt. Cook and 7m at Mt. Beatrice) and almost stopped the ablation of the overlying ice. This resulted in the formation of an ice-platform more than 30 m high. This led to a reduction of the existing negative mass balance of the affected Tasman and Hooker Glaciers. There was little noticeable alteration of the overall glacial regime due to the small scale of the debris covered area (4 and 1% of the ablation zones for the Tasman and Hooker Glaciers, respectively) but there is a significant contribution to supraglacial debris, which is passively transported toward the terminus. A conceptual model of the response of mountain valley glaciers to emplacement of extensive rock avalanche debris on the ablation zone has been proposed for the effect of this type of debris on terminal moraine formation based on enhanced 'dumping' of supraglacial sediments.

A new technique has been developed to distinguish rock-avalanche-derived sediment from sediment of glacial origin, based on the sedimentary characteristics of the finest fraction. Examination of rock avalanche sediment under the Scanning Electron Microscope showed that finer particles tend to form strong clumps, which comprise many smaller (down to nanometre-scale) clasts, named here 'agglomerates'. These agglomerates are present in the fine fraction of all examined rock avalanche deposits and absent in known non-rock-avalanche-derived glacial sediments. The agglomerates are characteristics of sediment produced under the high-stress conditions of rock avalanche emplacement and contrast with lower-stress process sub- and en-glacial environments. It is demonstrated that these agglomerates are present in some moraines in the Southern Alps of New Zealand that have been attributed to climate fluctuation. Consequently, this technique has the potential to resolve long-standing arguments about the role of rock avalanches in moraine formation, and to enhance the use of moraines in palaeoclimatological studies.

Ackerley D., Lorrey A., Renwick J.A., Phipps S.J., Wagner S., Dean S., Singarayer J., Valdes P., Abe-Ouchi A., Ohgaito R. and Jones J.M. (2011) Using synoptic type analysis to understand New Zealand climate during the Mid-Holocene. *Climate of the Past* 7(4), 1189-1207. DOI:10.5194/cp-7-1189-2011.

Arnold L.J., Roberts R.G., MacPhee R.D.E., Haile J.S., Brock F., Moller P., Froese D.G., Tikhonov A.N., Chivas A.R., Gilbert M.T.P., and Willerslev E. (2011) Dirt, dates and DNA: OSL and radiocarbon chronologies of perennially frozen sediments in Siberia, and their implications for sedimentary ancient DNA studies. *Boreas* 40, 417-445.

Bahn P. and Flenley J. (2011) Easter Island, Earth Island (3rd edition). Rapa Nui Press, Santiago.

Baker A., Bradley C., Phipps S., Fischer M., Fairchild I.J., Fuller L., Spotl C. and Azcurra C. (2012) Millennial-scale forward models and pseudoproxies of stalagmite $\delta^{18}O$: an example from NW Scotland. *Climate of the Past Discussions* 8, 869-907.

Bornemann A., Pirkenseer C.M., De Deckker P., Speijer R.P. (2012, in press) Oxygen and carbon isotope fractionation of marine ostracod calcite from the eastern Mediterranean Sea. *Chemical Geology.*

Bowler J.M., Gillespie R., Bolkjovac K., Johnson H. (2012) Wind v Water: Glacial Maximum records from the Willandra Lakes. In: Haberle S.G. and David B. (Eds) Peopled Landscapes: Archaeological and Biogeographic Approaches to Landscapes. Terra Australis 34, 271-296. ANU E-Press, Canberra (free download from http://epress.anu.edu.au).

Bush M., Flenley J.R. and Gosling W. (Eds) (2011) Tropical Rain Forest Responses to Climatic Change (2nd edition). Praxis, Chichester, 454 pp.

Cook E.J., van Geel B., van der Kaars S. and van Arkel J. (in press) A review of the use of non-pollen palynomorphs in palaeoecology with examples from Australia. *Palynology*.

De Deckker P., Moros M., Perner K., Jansen E. (2012) Influence of the tropics and southern westerlies on glacial interhemispheric asymmetry. *Nature Geoscience* 5, 266-269.

Ehlert C., Frank M., Haley B.A., Böninger U., De Deckker P., Gingele F.X. (2011) Tracing current regimes and continental inputs in the eastern Indian Ocean using radiogenic signatures of clay-sized sediments. *Geochemistry Geophysics Geosystems* 12, Q06017.

Fitzsimmons K.E. (2011) An assessment of the luminescence sensitivity of Australian quartz with respect to sediment history. *Geochronometria* 38(3), 199-208.

Fitzsimmons K.E. and Barrows T.T. (2012) Late Pleistocene aeolian reactivation downwind of the Naracoorte East range, South Australia. *Zeitschrift für Geomorphologie* 56(2), 225-237. DOI: 10.1127/0372-8854/2012/0068.

Fitzsimmons K.E., Markovic S.B., Hambach U. (2012) Pleistocene environmental dynamics recorded in the loess of the middle and lower Danube basin. *Quaternary Science Reviews* 41, 104-118. DOI: 10.1016/j.quascirev.2012.03.002.

Fitzsimmons, K.E., Miller, G.H., Spooner, N.A., Magee, J.W. (2012, in press) Aridity in the monsoon zone as indicated by desert dune formation in the Gregory Lakes basin, northwestern Australia. *Australian Journal of Earth Sciences*.

Flenley J.R. (2011) Ultraviolet insolation and the tropical rainforest: Altitudinal variations, Quaternary and recent change, extinctions and the evolution of biodiversity. In: Bush M., Flenley J.R. and Gosling W. (Eds). Tropical Rain Forest Responses to Climatic Change (2nd edition). Praxis, Chichester, Chapter 8.

Gehrels, W.R., Callard, S.L., Moss, P.T., Marshall, W.A., Blaauw, M., Hunter, J., Milton, J.A., Garnett, M.H. (2012) Nineteenth and twentieth century sea-level changes in Tasmania and New Zealand. *Earth and Planetary Science Letters* 315-316, 94-102.

Gergis J., Gallant A.J.E., Braganza K., Karoly D.J., Allen K., Cullen L., D'Arrigo R., Goodwin I., Grierson P. and McGregor S. (2012). On the long-term context of the 1997–2009 'Big Dry' in south-eastern Australia: insights from a 206-year multi-proxy rainfall reconstruction. *Climatic Change* 111(3), 923–944.

Gillespie R., Camens A.B., Worthy T.H., Rawlence N.J., Reid C., Bertuch F., Levchenko V., Cooper A. (2012) Man and megafauna in Tasmania: closing the gap. *Quaternary Science Reviews* 37, 38-47.

Hartland A., Fairchild I.J., Lead J.R., Borsato A., Baker A., Frisia S. and Baalousha M. (2012) From soil to cave: transport of trace metals by natural organic matter in cave dripwaters. *Chemical Geology* 304-305, 68-82. DOI:10.1016/j.chemgeo.2012.01.032.

Joyce E. B., McCann D. A. (2011) Burke & Wills: The Scientific Legacy of the Victorian Exploring Expedition. CSIRO Publishing, Collingwood, 343pp. (In particular: Geology, soils and landscapes of the expedition route, Chapter 3: 58-96). *To buy the book:*

http://www.burkeandwills150.info/images/bwpdf/bw_book_order_form.pdf
http://www.publish.csiro.au/nid/18/pid/6733.htm

Kemp J., Radke L.C., Olley J., Juggins S., De Deckker P. (2012) Holocene lake salinity changes in the Wimmera, southeastern Australia, provide evidence for millennial-scale climate variability. *Quaternary Research* 77, 65-76.

Kermode S.J., Cohen T.J., Reinfelds I.V., Nanson G.C., Pietsch T.J. (2012) Alluvium of antiquity: polycyclic terraces in a confined bedrock valley. *Geomorphology* 139-140, 471-483.

Kershaw A.P. and van der Kaars S. (in press) Tropical Quaternary climates in Australia and the South-West Pacific. In: Metcalfe, S. (ed.) Quaternary Climates in the Tropics. Blackwell.

Kershaw A.P., van der Kaars S. and Flenley J.R. (2011) The Quaternary history of tropical rainforests. In: Bush M., Flenley J.R. and Gosling W. (Eds). Tropical Rain Forest Responses to Climatic Change (2nd edition). Praxis, Chichester, Chapter 4.

Lambeck, K., Purcell, A., and Dutton A. (2012) The anatomy of interglacial sea levels: the relationship between sea levels and ice volumes during past interglacials, *Earth and Planetary Science Letters*. DOI:10.1016/j.epsl.2011.08.026.

Lim N., Munday C.I., Allison G.E., O'Loingsigh T., De Deckker P., Tapper N.J. (2011) Microbiological and meteorological analysis of two Australian dust storms in April 2009. *Science of the Total Environment* 412, 223-231.

Mariethoz G., Kelly B. and Baker A. (2012) Quantifying the value of laminated stalagmites for paleoclimate reconstructions. *Geophsyical Research Letters* 39, L05407. DOI:10.1029/2012GL050986.

Morelli C., Gasparon M., Fierro D., Hu W.-P., Zawadzki A. (2012) Historical trends in trace metal and sediment accumulation in intertidal sediments of Moreton Bay, southeast Queensland, Australia. *Chemical Geology* 300-301, 152-164.

Neukom R. and Gergis J. (in press, 2011) Southern Hemisphere high-resolution palaeoclimate records of the last 2000 years. *The Holocene*. DOI: 10.1177/0959683611427335.

Newnham R.M., Vandergoes M., Sikes E., Carter L., Wilmshurst J., Lowe D.J., McGlone M.S. and Sandiford A. (in press) Does the bipolar seesaw extend to the terrestrial southern mid-latitudes? *Quaternary Science Reviews*.

Nicholas W.A., Chivas A.R., Murray-Wallace C.V. and Fink D. (2011) Prompt transgression and gradual salinisation of the Black Sea during the early Holocene constrained by amino acid racemization and radiocarbon dating. *Quaternary Science Reviews* 30, 3769-3790.

Pedro J.B., Rasmussen S.O. and van Ommen T.D. (2012) Rapid coupling of Antarctic temperature and CO_2 during deglaciation. *Climate of the Past Discussions* 8, 621-636. DOI:10.5194/cpd-8-621-2012.

Raeis M.M., Abed R.M.M., Ramette A., Hübner V., De Deckker P., De Beer D. (2012) Microbial diversity of eolian dust sources from saline lake sediments and biological soil crusts in arid Southern Australia. *FEMS Microbiology Ecology*. DOI: 10.1111/j.1574-6941.2011.01289.

Reznichenko N.V., Davies T.R.H., Shulmeister J. and Larsen S.H. (2012) A new technique for identifying rock-avalanche-sourced sediment in moraines and some paleoclimatic implications. *Geology* 40, 319-322. doi:10.1130/G32684.1

Rogers J., De Deckker P. (2011) Environmental reconstructions of the upper 500 m of the southern Indian Ocean over the last 40 ka using Radiolarian (Protista) proxies. *Quaternary Science Reviews* 30, 876-886.

Russon T., Elliot M., Sadekov A., Cabioch G. Corrége T., De Deckker P. (2011) The mid-Pleistocene transition in the subtropical southwest Pacific. *Paleoceanography* 26, PA1211.

Spooner M.I., De Deckker P., Barrows T.T., Fifield L.K. (2011) The behaviour oft he Leeuwin Current offshore NW Australia during the last five glacial-interglacial cycles. *Global and Planetary Change* 75, 119-132.

Van der Kaars S., Williams M.A.J., Bassinot F. Guichard F., Moreno E., Dewilde F. and Cook E.J. (in press). The influence of the 73 ka Toba super-eruption on the ecosystems of northern Sumatra as recorded in marine core BAR94-25. *Quaternary International*.

Wegner A., Gabrielli P., Wilhelms-Dick D., Ruth U., Kriews M., De Deckker P., Barbante C., Cozzi G., Delmonte B., Fischer H. (2012) Change in dust variability in the Atlantic sector of Antarctica at the end of the last deglaciation. *Climate of the Past* 8, 135-147.

Wilkins D., De Deckker P., Fifield L.K., Gouramanis C., Olley J. (2012, in press) Comparative optical and radiocarbon dating of laminated Holocene sediments in two maar lakes: Lake Keilambete and Lake Gnotuk, south-western Victoria, Australia. *Quaternary Geochronology.*

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Quaternarist, A.B., 2000. The top twenty field sites in Australia. *Journal of Field Studies*, 62 (2), 191-200.

Quaternarist, A.B. and Palynologist, C.D., 2000. The top twenty field sites in Australia. In A.N. Smith (editor). *A Guide to Happy Quaternary Studies*. Fun Book Company, Sydney. 109-146.

Quaternarist, A.B., Palynologist, C.D. and Geomorphologist, E.F., 2000. *A Guide to Happy Quaternary Studies*. Fun Book Company, Sydney. 300 pp.

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