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Quaternary AUSTRALASIA

Holocene palaeoenvironments in western Tasmania

Organic proxies applied to Murray Canyon sediments

AQUA researchers travel to the Coorong

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COVER: Mihiura Swamp, Tubuai, French Polynesia. This swamp is a palaeoecological research site as part of an ARC Discovery funded project (M. Prebble and N. Porch) gauging the utility of sub-fossil insects and plants as proxies for human presence on remote Pacific islands. Photo: Matthew Prebble.

LEFT: Embi Lakes, Oro Province, Papua New Guinea. Geoff Hope and Dougal in dugout canoe on a crocodylius lake as part of a reconaissance palaeoecological expedition to the region. A 1m piston core was retrieved. This project is funded by the Research Institute of Humanity and Nature, Kyoto (Leader: Yo-Ichiro Sato). Photo: Matthew Prebble.

Editorial

Dear Fellow Quaternarists,

Quaternary scientists in the Australasian region continue their active work both in research and outreach. Both these aspects of scientific communication are highlighted in this issue of *Quaternary Australasia.* In this issue, we publish two research reports by students working in Australian Quaternary research, both of which were presented at the AQUA meeting held at Victor Harbour, South Australia, in December. Lydia Mackenzie and colleagues reconstruct environmental conditions in western Tasmania over the Holocene using pollen and charcoal. Raquel Lopes dos Santos and others apply innovative organic proxies in order to develop records of palaeoclimatic change in the Murray Canyons region, just offshore from southeastern South Australia – a study particularly topical given the location of the AQUA conference near the Murray River mouth. In addition, Anna Sim gives us an account of the field trip to the Coorong which was run for the conference.

Several additional meetings have been held recently, and reports on these are included in this issue. Mirani Litster describes the Australian Archaeological Association conference which was held in Noosa in December last year (just prior to the AQUA meeting). We also include an account of the Southern Connections and Convergences Meeting which took place on Waiheke Island near Auckland at the end of last year. The upcoming PAGES Young Scientists' Meeting, soon to be held in Oregon, USA, will be an excellent opportunity for postgraduate students and early career researchers to present the results of their research. Four of the young scientists supported by AQUA to attend this meeting have kindly provided their abstracts for publication in this issue.

In terms of outreach, several members of the Quaternary community were in attendance at the Science Meets Parliament event in Canberra in March. Rachael Skinner was a student representative at the meeting, and her scientist's perspective of the political world is included in this issue. It is critical that we as scientists continue to improve our level of visibility in the public and political spheres; it is not only our responsibility as scientists and researchers, but also pivotal to ensure continued support and perceived relevance of our work. One measure of this is through research funding, and Simon Haberle has written a report on success in the most recent Australian Research Council funding round.

We also include a review of the recently published book "The Bone Readers" by Claudio Tuniz, Richard Gillespie and Cheryl Jones. Helen Cekalovic provides a refreshingly balanced viewpoint of a book which deals with the trials and controversies in the Australian archaeological and Quaternary research fields.

Best wishes

Kathryn Fitzsimmons

President's Pen

Dear Quaternarists,

It has been a busy few months with AQUA's engagement with the Australian government. Firstly, AQUA was well represented at this year's Science Meets Parliament meeting, by our student representative, Rachel Skinner (see her report in this issue of QA) and myself. A key focus of the meeting was climate change and I feel we did have some impact, along with other notable Quaternarists, including John Dodson and Henk Heijnis, in providing a Quaternary perspective on this significant issue. This meeting provides an excellent opportunity to engage with the Australian parliament, particularly for our student members and one issue I noted was the fact that AQUA was one of the few organisations at this event that actively includes student representatives. Secondly, AQUA was also called to provide a witness statement (based on our submission) to the Australian House of Representative Standing Committee on climate change and environmental impacts on coastal communities at the Queensland Parliament on April 28. Craig Sloss and I attended on behalf of AQUA and the submission was well received by the committee, which identified the importance of a palaeo-perspective on environmental impacts of future climate change on coastal communities. Thirdly, I would also like to encourage our New Zealand and other Oceania members to contact the AQUA executive to provide assistance with engagement with their governments and/or industry – I am fully aware that we are an Australasian organisation and need to reach out beyond the Australian border, so please let me know if there is anything we can do to help.

Finally, I would like to highlight our support, in association with the Australian Research Council Research Network for Earth System Science (ARCNESS), of a number of postgraduate students and early career academic attendance of the PAGES Young Scientist Meeting at Oregon State University, USA in July and they are as follows:

- Sophie Lewis from the Research School of Earth Sciences, Australian National University.
- Joelle Gergis from the School of Earth Sciences, University of Melbourne.
- Michael Griffiths from the School of Earth Sciences, University of Newcastle.
- Lynda Petherick from the School of Geography, Planning and Environmental Management, University of Queensland.
- Steven Phipps from the Climate Change Research Centre, University of New South Wales.

Expect to see more details of their research and a report on this conference in a future issue of QA. I would also like to acknowledge Peter Kershaw, Louise Newman (PAGES) and ARCNESS for their support in the development of this opportunity for postgraduates and early career researchers.

Best Wishes

Patrick

Mid to Late Holocene vegetation and environments of Lake Selina Swamp, western Tasmania.

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Abstract

Studies of Late Quaternary environments conducted within western Tasmania indicate vegetation transitions are a result both of changing climate and anthropogenic factors. In an effort to tease apart these two driving forces a 72 cm sediment core was extracted from the Lake Selina swamp. This core provides a record of vegetation and environmental change from the mid to late Holocene periods with four zones identified in the pollen record, the bottom two zones indicate a low level of human occupation (LSSA and LSSB), then a period of transition marking increased Aboriginal occupation in the area (LSSC), followed by a relatively high level of human occupation (including European settlement) towards the top of the core (LSSD). The results of this study support similar records from within the region, depicting an expansion of rainforest taxa between 9,000-5,000 BP, perhaps indicating a climatic optimum, which then shift to more open vegetation as drier conditions prevailed. The suggested mechanism for the observed regional alteration may be related to the increasing strength and frequency of El Niño events after 5,000 BP, creating a shift towards more secondary forest. Charcoal concentrations at the Lake Selina swamp site indicate a complex relationship between burning, human occupation and landscape alterations. Higher fire frequency inferred by larger carbonised particles values are observed during the climatically optimum zones of LSSA and LSSB rather than during the drier, late Holocene, zones of LSSC and LSSD. This suggests that eucalypt forests may support larger fires than heath due to there being more available fuel. Alternatively increased human occupation may have disrupted natural fire occurrence, lowering the charcoal values in the upper zones of the Lake Selina swamp record, encouraging the establishment of disclimatic heath and shrub lands. The results of this study suggest that the influence of Aboriginal fire use in the Australian landscape requires further investigation before this complex relationship can be understood. Future studies must also take into account the effect of increased sedimentation rates on increasing the carbonised particle representation in the interpretation of the charcoal record.

Key Words: Quaternary, Palaeoecology, western-Tasmania, Aboriginal burning.

Introduction

The majority of Late Quaternary studies conducted within western Tasmania indicate regional vegetation trends to be a result of both changing climate and anthropogenic factors (Colhoun, 1986; Van De Geer, 1988; Colhoun *et al*., 1999; Moss *et al*., 2007). A study in King Valley, western Tasmania, shows a major climatic shift approximately ca.13 ka BP from a cold, alpine climate to a warmer and wetter temperate environment (Colhoun and Fitzsimons, 1990). This trend is supported at a regional level by other local studies, with open Asteraceae-rich grasslands dominating the region prior to 13 ka BP being replaced by cool temperate rainforest and eucalypt-rich sclerophyll forests as climatic amelioration occurred through to the early Holocene (Colhoun *et al*., 1986; Van De Geer, 1988). It is suggested that after ca. 13 ka many of the vegetation changes observed are a result of localised environmental factors, rather than following regional climate patterns, reflecting relatively stable community dynamics in western Tasmania during the Holocene period (Markgraf *et al*., 1986).

Fire is thought to be a key control on community dynamics in western Tasmania during the Holocene (Jackson, 1968; Jones, 1969; Kirkpatrick, 1977). It has been suggested that burning intensity and frequency play a key role in the distribution of rainforest, sclerophyll forest and buttongrass moorlands, although there is debate about the relative scale (regional vs local) of the impact of fire, as well as the role of anthropogenic burning in shaping the Tasmanian landscape (Jones, 1975; Kirkpatrick, 1977; Ellis and Thomas, 1988; Mount, 1979; Macphail, 1980; Thomas and Hope, 1994; Moss *et al*., 2007). In addition, there is strong evidence of continuous Aboriginal occupation of western and central Tasmania from before 30,000 to ~13,000 years BP (Cosgrove, 1989; Cosgrove *et al*., 1990). However, it has been suggested that the Holocene rainforest of western Tasmania acted as a barrier to Aboriginal settlement, with the abandonment of caves in south-western Tasmania at 12,000 years BP supporting this theory (Kiernan *et al*., 1983). In contrast, Webb *et al*. (1994) suggests that Aboriginal camps and paths were located in the western Tasmanian rainforests and suggests that the abandonment of these caves were more likely a result of increasingly humid conditions

making the cave inhabitable rather than a regional expansion of rainforests.

European settlement is seen to have caused dramatic changes to the Tasmanian environment, with the introduction of exotic taxa, increased sedimentation rate and significant vegetation clearance (Thomas and Hope, 1994; Cosgrove, 1999; Moss *et al*., 2007). Settlement in the western Tasmanian region is recorded as occurring from the mid-1830s to early 1840s with land uses including logging, mining and farming (Kirkpatrick, 1977). Rainforest taxa, such as *Phyllocladus*, were eliminated in many areas due to their use in mining and smelting operations in the late 19th century (Kirkpatrick, 1977), which along with further clearing may have helped sclerophyll vegetation, grasses and heath to become established. It has also been suggested that cattle, both feral and farmed, had a significant impact on the western Tasmanian landscape through their hard-hooves increasing erosion and sedimentation rates, as well as vegetation loss associated with grazing (Thomas and Hope, 1994).

The purpose of this study is to examine the long term response of vegetation to localised environmental factors and human settlement, within a climatic context during the mid to late Holocene. The Lake Selina swamp core examined for this study provides a detailed record for this period, allowing insight into regional vegetation trends driven by human occupation, both Aboriginal and European.

Materials and Methods

Study site

Lake Selina is located in the West Coast Range of Tasmania at 41° 53'S; 145° 36'E (Figure 1) at an altitude of 516 m. The local climate is humid, with precipitation occurring 230 – 240 days per year. Mean annual precipitation at Lake Selina is on average 3200 mm, while temperatures in the area range from 13.5 °C in February to 5 °C in July (Colhoun *et al*., 1999). The peat and podzolic soils of the Lake Selina area restrict drainage, while fire has allowed low lying scrub and heath to dominate the region despite climatic conditions being conducive for rainforest

Figure 1: Photograph of Lake Selina Swamp (Patrick Moss).

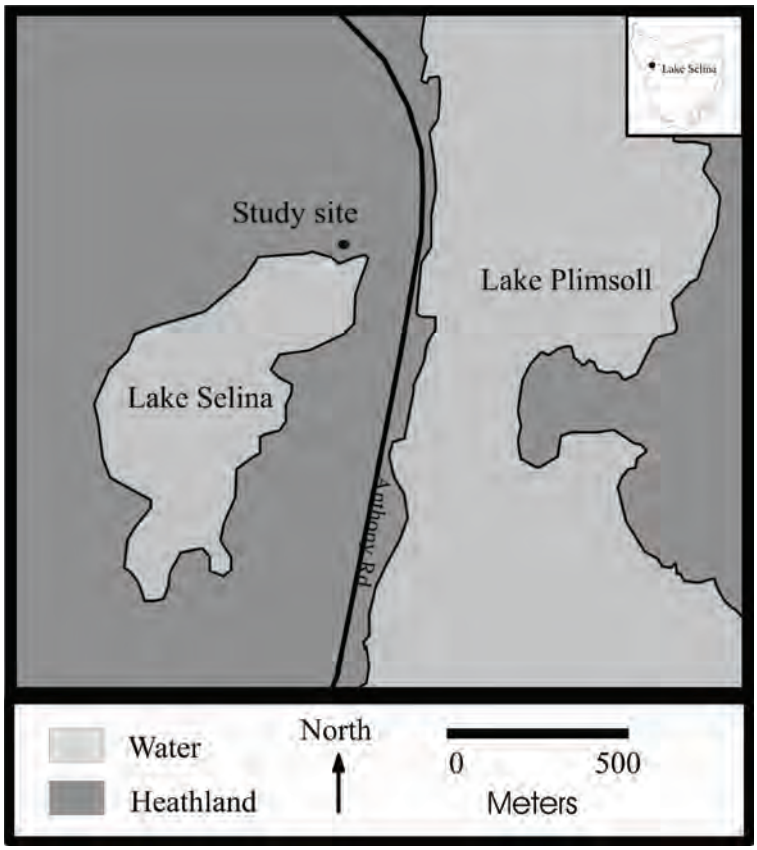

Figure 2: Location of Lake Selina study site, Western Tasmania

growth in western Tasmania (Jackson, 1965: 1968; Kirkpatrick, 1977; Colhoun *et al*., 1999). Significant species located within the Lake Selina heathlands include *Sprengelia incarnata, Leptospermum nitidum,* and *Melaleuca squamea*, while dominant scrub species include *L. nitidum, M. squamea, Acacia mucronata, Monotoca glauca, Bauera rubioides, Agastachys odorata, Cenarrhenes nitida* and *Telopea truncate.* Aquatic vegetation located around the lake edge is characterised by *Restionaceae* sp. and *Cyperaceae* sp. with *Juncus* sp., *Isoetes cunninghamii* and *Myriophyllum* sp. present. Extensive areas of cool temperate rainforest occur to the east of the lake, while swamp forest communities occur to the southwest.

Pollen, charcoal and sedimentological analysis
A 72 cm sediment core was extracted using a Russian D-section corer from the Lake Selina swamp region on December 12, 2007 and 1 cm^3 sections of the core were sub-sampled at 7 cm intervals along the length of the core for pollen and charcoal analyses. The samples were prepared for analysis based on the method of Van der Kaars (1991). This technique uses sodium pyrophosphate to disaggregate clays and silts, an eight micron sieve to remove clays and sodium polytungstate heavy liquid solution (specific gravity of 2.0) to separate the organic material (including pollen and charcoal) from the inorganic component of the core. A marker spore of *Lycopodium clavatum* was added to each sample to provide a relative estimate of pollen concentration (Stockmarr, 1971). Slides were mounted in glycerol and counted using a light microscope at X 400 resolution. Pollen identification was assisted by the Australasian Pollen and Spore Atlas (2008) and Macphail and Hope (2003). Some of the pollen types observed could be classed to a species level such as *Nothofagus cunninghamii* and *Pomaderris apetala* while others were grouped at its family level, including Poaceae, Cyperaceae and Epacridaceae.

Accelerator mass spectrometer radiocarbon dating for a single, mid-range sample was conducted at the Australian Nuclear Science and Technology facility at Lucas Heights, New South Wales. The sample was selected after initial analysis of the pollen record suggested a distinct period of vegetation change at around 30 cm, giving a date of 3240 +/- 30 yrs BP. This ^{14}C date was then calibrated using the SHCal04 calibration curve, specific for the Southern Hemisphere, resulting in a date of 3410 +/- 63 cal yr BP (McCormac *et al*., 2004). Dried samples of the core were also ashed in a high temperature furnace at 490°C to remove the organic fraction and retain the inorganic sediments. Charcoal concentration (fragments > 2 µm) was calculated for each sample from the total observed fragments in three consecutive transects, using the point estimation method (Clark, 1982). The pollen diagram (Figure 3) was produced using TILIA and includes the ash content (% inorganic sediment), pollen concentration (grains per cm^3) and charcoal concentration (carbonized particles per cm cm^3 x 1000). The diagram has been divided into zones determined by CONISS (Grimm, 2004) as a result of stratigraphically constrained classifications of taxa included in the pollen sum.

Results

The pollen diagram has been divided into four zones as assigned by CONISS (Grimm, 2004) and each zone is discussed in detail below:

Zone LSSA (70-53 cm)

This zone observes the highest occurrence of forest taxa in the record, with extensive areas of eucalypt forest and an open understorey [suggested by relatively high values of Poaceae and Asteraceae (Tubulifloreae)]. Zone LSSA also contains the most significant occurrence of cool temperate rainforest. The aquatic taxa are dominated by Restionaceae, while this zone observes the highest charcoal value and pollen concentrations in the record. Inorganic content ranges from 20 to 40 %.

Zone LSSB (53-33 cm)

This zone is still dominated by eucalypt forest with an open understorey (with a peak in *Eucalyptus* observed at 42 cm), but there is a reduction in all rainforest taxa except for *Nothofagus cunninghamii*. Restionaceae values decrease in this zone, while there is a slight increase in Cyperaceae values. Inorganic values range from 30 to 40%, while pollen concentrations are similar to zones LSSA and LSSC.

Zone LSSC (33-24 cm)

A significant transition in vegetation occurs in this zone, with eucalypt values sharply declining and Epacridaceae values dramatically increasing. This suggests a change from eucalypt forest to heath environments. Increased disturbance is also suggested by a significant increase in pteridophyte values with inorganic values reaching their highest point in the record (~ 60 %). Charcoal and aquatic taxa values undergo a significant decline in this zone.

Zone LSSD (24-0 cm)

Epacridaceae (reflecting heath) continues to dominate this zone and there is an increase in sclerophyll forest taxa, particularly *Acacia* and *Callitris*, as well as a slight increase in eucalypt pollen at the top of the core. Aquatic values, particularly Cyperaceae, significantly increase in this zone, while pteridophytes values sharply decline. Charcoal values are generally lower in this zone, although there is a peak at 7 cm and inorganic values range from 5 to 20 %.

Discussion

Vegetation trends

This study from Lake Selina swamp demonstrates changing vegetation trends over a relatively short time period during the mid to late Holocene. The dominance of eucalypt forest with an open understorey, an increased representation of rainforest in zones LSSA and LSSB and increase in Epacridaceae (zones LSSC and LSSD), correlates well to similar levels in a previous study of a sediment core taken directly from Lake Selina (Colhoun *et al*., 1999). Several studies (including Colhoun and van de Geer, 1986; Colhoun *et al*., 1992; Harle *et al*., 1993; van de Geer *et al*., 1991; Thomas and Hope, 1994) report an expansion in rainforest taxa between 9,000 to 5,000 years BP, which may reflect a climatic optimum during the early to middle Holocene period (Macphail, 1979). This is thought

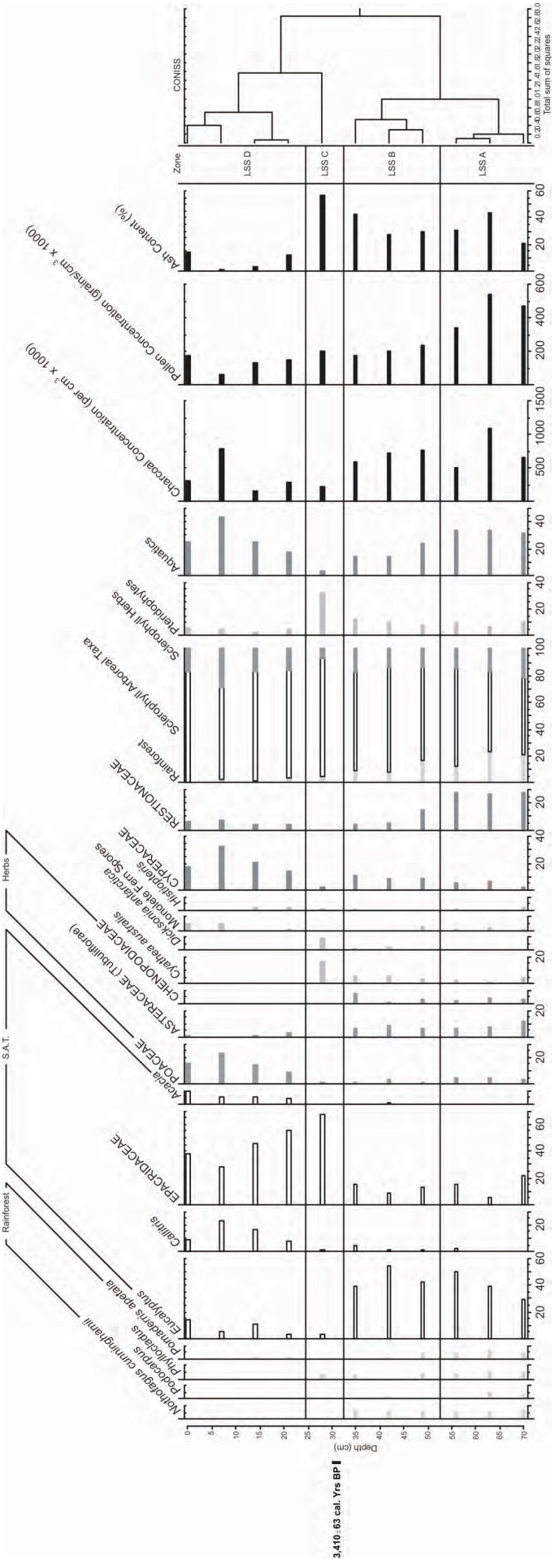

Figure 3: Lake Selina Swamp pollen diagram.

to represent widespread increases in precipitation with some smaller rises in temperature in western Tasmania (Colhoun *et al*., 1999). The optimum was then succeeded by drier conditions during the later part of the Holocene, which is reflected by more open vegetation found at all sites at this stage (Colhoun and van de Geer, 1986; Harle *et al*., 1993; Colhoun *et al*., 1992; van de Geer *et al*., 1991).

The results of this study support this general interpretation, with the dominance of sclerophyll forest reflecting the end of the climatic optimum period, which then transitions to a more open heath environment after ~ 3,400 cal yr BP. The cause of this alteration may be related to an increase in El Niño strength and frequency that began around 5,000 years BP (Haberle *et al*., 2001; Haberle and Ledru, 2001; Hope *et al*., 2004), which has been suggested as a cause of shifts towards more secondary forests and increased burning in the Austral-Asian region. Specifically, the shift to open heath recorded at Lake Selina swamp reflects an increase in the amplitude of El Niño activity around ~3,600 years BP (Gagan *et al*., 2004). This suggests that alterations in the strength and duration of the El Niño –Southern Oscillation phenomena may be a driving force in the vegetated landscape of western Tasmania during the mid to late Holocene period. However, the scale of the alteration may require a more complex explanation. Zone LSSC clearly demonstrates a shift from open eucalypt forest to heath, but associated with this change is a peak in ferns and a rising trend in ash content during zones LSSB and LSSC, which suggests increased disturbance (Moss *et al*., 2007). This may reflect an increase in human occupation in the region, which led to altered burning regimes and promoted the expansion of heaths, as well as increased sedimentation rates. The expansion of heathlands and rise in sedimentation rate as a result of increasing human occupation around 3000 years BP has been found at a study conducted at the Gog Summit, central Tasmania (Webb *et al*., 1994). In contrast to several studies from across Tasmania there is no clear indication of European arrival to the region. European settlement is usually signified by the occurrence of exotic pollen taxa (Moss *et al*., 2007), and the absence of this indicator suggests that there was minimal landscape alteration associated with European activity in the immediate area of Lake Selina.

Fire occurrence

Fire in the Late Holocene period is seen to have had a great influence on driving vegetation trends and creating current community distributions in the western Tasmanian region (Moss *et al*., 2007; Colhoun *et al*., 1999). Fire in the Tasmanian landscape is suggested as the driving force in replacing climatically optimum temperate rainforest taxa with open sclerophyll vegetation communities (Jackson, 1968; Jones, 1975; Kirkpatrick, 1977). However, the results of this study suggest a complex relationship between burning, human occupation and landscape alterations. Higher fire frequencies, suggested by larger carbonized particle values, are observed in the climatic optimum zones of LSSA and LSSB, rather than the drier Late Holocene zones of LSSC and LSSD. This may reflect the fact that eucalypt forest can support larger fires than heath, as they contain a greater amount of fuel to burn. Alternatively, a drier climate and alterations in burning patterns associated with increased human occupation may play a role in lowering the charcoal values in the upper part of the Lake Selina swamp record. The complex relationship between burning, Aboriginal occupation and landscape modification is supported by Mooney *et al*. (2001) in their study of pre-European fire in the Sydney coastal region. They suggested that the influence of Aboriginal fire use in the Australian landscape requires critical analysis. Furthermore, alterations in sedimentation rates may also impact the charcoal record in the Lake Selina swamp record. Moss *et al*. (2007) demonstrated how increased sedimentation rates may increase carbonized particle representation in a core from central Tasmania, which is also suggested by the higher inorganic values in the lower section of core examined in this study. This suggests that sedimentation processes also need to be considered in association with landscape modification in the interpretation of charcoal records.

Conclusion

This study has examined the response of vegetation to localised environmental factors during the mid to late Holocene period. The combined impacts of burning, human occupancy and a drying climate have been found to result in the disclimatic vegetation present at Lake Selina today. The intensification of El Niño events during the Late Holocene period, and further increase in amplitude after ~3,600 BP (Gagan *et al*., 2004; Haberle *et al*., 2001; Haberle and Ledru, 2001; Hope *et al*., 2004) is suggested as a possible driving mechanism for the change in vegetation and burning regimes observed in western Tasmania, with intensification of human occupancy aiding vegetation transition. Further studies in the area need to consider sediment processes along with charcoal records to better understand the role of Aboriginal fire on the Tasmanian landscape.

Acknowledgements

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References

- APSA Members* (2007) The Australasian Pollen and Spore Atlas V1.0. Australian National University, Canberra. http://apsa.anu.edu.au.
- Bridle, K.L., Kirkpatrick, J.B. (1999) Comparative effects of stock and wild vertebrate herbivore grazing on treeless subalpine vegetation, eastern Central Plateau, Tasmania. *Australian Journal of Botany* 47, 817-835.
- Clark, J.S. (1982) Point count estimation of charcoal in pollen preparations and thin sections of sediments. *Pollen et Spores* XXIV (3-4), 523-535.
- Colhoun, E.A. (1986) Field problems of radiocarbon dating in Tasmania. *Papers and Proceeding of The Royal Society of Tasmania* 120, 1-6.
- Colhoun, E.A., van de Geer G. (1986) Holocene to middle last glaciation vegetation history of Tullabardine Dam, western Tasmania. *Proceedings of the Royal Society of London* B29, 177-207.

- Colhoun, E.A., Fitzsimons, S.J. (1990) Late Cainozoic Glaciation in Western Tasmania, *Australia. Quaternary Science Reviews* 9, 199-216.
- Colhoun, E.A., van de Geer, G. and Fitzsimons, S.J. (1992) Late Quaternary organic deposits at Smelter Creek and vegetation history of the Middle King Valley, Western Tasmania. *Journal of Biogeography* 19, 217-227.
- Colhoun, E.A., Pola, J.S., Barton, C.E. and Heijnis, H. (1999) Late Pleistocene vegetation and climate history of Lake Selina, western Tasmania. *Quaternary International* 57/58, 5-23.
- Cosgrove, R. (1989) Thirty thousand years of human colonization in Tasmania: New Pleistocene dates. *Science*, 243, 1706-1708.
- Cosgrove, R. (1999) Fourty-Two Degrees South: The Archaeology of Late Pleistocene Tasmania. *Journal of World Prehistory*, 13 (4), 357-402
- Cosgrove, R. Allen, R.J., Marshall, B. (1990) Paleoecology and Pleistocene occupation in South Central Tasmania. *Antiquity*, 64, 59-78.
- Ellis, R.C., Thomas, I. (1988) Pre-Settlement and Post Settlement Vegetational Change and Probable Aboriginal Influence in a Forested Area in Tasmania. In *Australia's ever changing forests*, (Eds Frawley, K.J., Semple, N.) Department of Geography and Oceanography, Australian Defence Force Academy, Special Publication Number 1., Campbell, ACT, pp 199-214.
- Gagan, M.K., Hendy, E.J., Haberle, S.G., Hantoro, W.S. (2004) *Quaternary International.* 118-119, 127-143.
- Grimm, E.C. (2004) TG View version 2.0.2. *Pollen drawing software*. Illinois State Museum, Springfiels, IL.
- Haberle, S.G., Hope, G.S., van der Kaars, S. (2001) Biomass bruning in Indonesia and Papua New Guinea: natural and human induced fire events in the fossil record. *Palaeogeography, Palaeoclimatology, Palaeoecology.* 171, 259-268.
- Haberle, S.G. and Ledru, M-P. (2001) Correlations among charcoal records of fires from the past 16,000 years in Indonesia, Papua New Guinea and Central and South America. *Quaternary Research* 55, 97-104.
- Harle, K.J., Kershaw, A.P., Macphail, M.K. and Neyland, M.G. (1993) *Australian Journal of Ecology.* 18, 161-170.
- Hope, G., Kershaw, A.P., van der Kaars, S., Xiangjun, S., Liew, P-M., Heusser, L.E., Takahara, H., McGlone, M., Miyoshi, N. and Moss, P. (2004). History of vegetation and habitat change in the Austral-Asian region. *Quaternary International* 118-119, 103-126.
- Jackson, W.D. (1965) Vegetation. In: Davies JL. (Ed), *Atlas of Tasmania*. Lands and Surveys Department, Hobart, pp. 30-35.
- Jackson, W.D. (1968) Fire, air, earth and water – an elemental ecology of Tasmania. *Proceedings of the Ecological Society of Australia* 3, 9-16.
- Jones, R. (1975) The Neolithic, Palaeolithic and hunting gardener; Man and land in the Antipodes. In '*Quaternary studies'*. (Eds RP Suggate, MM Cresswell) pp. 21-34. The Royal Society of New Zealand Wellington
- Kiernan, K., Jones, R., Ransom, D. (1983) New evidence from Fraser Cave tor glacial age man in South-west Tasmania. *Nature*, 301, 28-32.
- Kirkpatrick, J.B. (1977) The impact of man on the vegetation of the west coast region. In; Banks MR, Kirkpatrick JB (Eds), *Landscape and Man*. Royal Society of Tasmania, Hobart. pp. 55-80.
- Macphail, M.K. (1979) Vegetation and climates in Southern Tamania since the Last Glaciation. *Quaternary Research*, 11, 306-341.
- Macphail, M.K. (1980) Regeneration processes in Tasmanian forests; a long-term perspective based on pollen analysis. *Search*, 11, 184-190.
- Macphail, M. and Hope, G.S. (2003) Natural Histories: An illustrated guide to fossil pollen and spores preserved in swamps and mires of the Southern Highlands, NSW.
- Markgraf, V., Bradbury, J.P. and Busby, J.R. (1986) Paleoclimates in Southwestern Tasmania during the last 13,000 years. *Palaios*, 1 , 368-380.
- McCormac, F.G., A. H. Hogg, P. G. Blackwell, C. E. Buck, T. F. G. Higham and P. J. Reimer (2004). SHCal04 Southern Hemisphere calibration, 0 - 11 kyr BP. *Radiocarbon* 46(3): 1087-1092.
- Moss, P.T., Thomas, I. and Macphail, M. (2007) Late Holocene vegetation and environments of the Mersey Valle, Tasmania. *Australian journal of Botany*. 55, 74-82.
- Mooney, S.D., Radford, K.L., Hancock, G. (2001) Clues to the 'burning question'; pre-European fire in the Sydney coastal region from sedimentary charcoal and palynology. *Ecological Managment and Restoration*, 2(3), 203-212.
- Mount, A.B. (1979) Natural regeneration processes in Tasmanian forests. *Search*, 10, 180-186.
- Stockmarr, J. (1971) Tablets with spores used in absolute pollen analysis. *Pollen et Spores* 13, 615-621.
- Singh, G., Kershaw, A.P., Clark, R. (1978) Quaternary vegetation and fire history in Australia. In '*Fire and the Australian Biota*'. (Edited by Gill AM, Groves KH, Noble IR) pp. 23-54 (Australian Academy of Science, Canberra 1981.)
- Thomas, I., Hope, G. (1994) An example of Holocene vegetation from Cameroons Lagoon; A near treeline site on the Central Plateau, Tasmania. *Aust. J. Ecol.* 19, 150-158.
- Van de Geer, G., Fitzsimons, S.J., Colhoun, E.A. (1988) Holocene to Middle Last Glaciation vegetation history, Newall Creek, Western Tasmania. *New Phytol.* 111, 549-558.
- Van de Geer, G., Fitzsimons, S.J., Colhoun, E.A. (1991) Holocene Vegetation History from king river railway bridge Western Tasmania. In: *Papers and Proceedings of the Royal Society of Tasmania.* 125, 73-77
- van der Kaars, W.A. (1991) Palynology of eastern Indonesian marine piston-cores: A late Quaternary vegetational and climatic record for Australasia. *Palaeogeography, Palaeoclimatology, Palaeoecology* 85, 239-302.
- Webb, J.A., Thomas, I., Thiele, K. (1994) The physical setting of the Gog Range. In: Sagona AC (Ed) *Bruising the Red Earth-ochre mining and ritual In Aboriginal Tasmania.* Melbourne University Press, Melbourne pp. 39-51

Application of organic proxies to reconstruct past climatic conditions of the Murray Canyons area, offshore South Australia.

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Introduction

The Australian continent and surrounding waters have experienced large climatic variations during the Quaternary period (Bleys *et al.*, 1994). Large changes in the hydrology during this period led to dramatic changes in the landscape and biodiversity on the continent (Kershaw *et al.*, 2007; Hill *et al.*, 2009). Also, in the surrounding waters, strong oceanographic changes occurred causing variations in primary productivity (Gingele and De Deckker, 2005). However, most palaeoclimatic reconstructions have come from lake sediments spanning short time intervals and only a limited number of palaeoclimate studies based on marine sediment cores have so far been attempted to reconstruct past oceanographic conditions around Australia. In this study, we have analysed marine sediments covering the last ~22 kyr from core MD 2607 located at 856 m water depth in the Murray Canyons area, along the southern margin of Australia (Fig.1). This area received, at times, large inputs of fluvial clays from the Murray-Darling River system (the largest river system in Australia), and also occasionally aeolian dust, most likely sourced from central and western Australia (Gingele *et al.*, 2007). Thus, sediment cores in this area are good archives for palaeoclimate reconstructions, both from a marine as well as a terrestrial perspective.

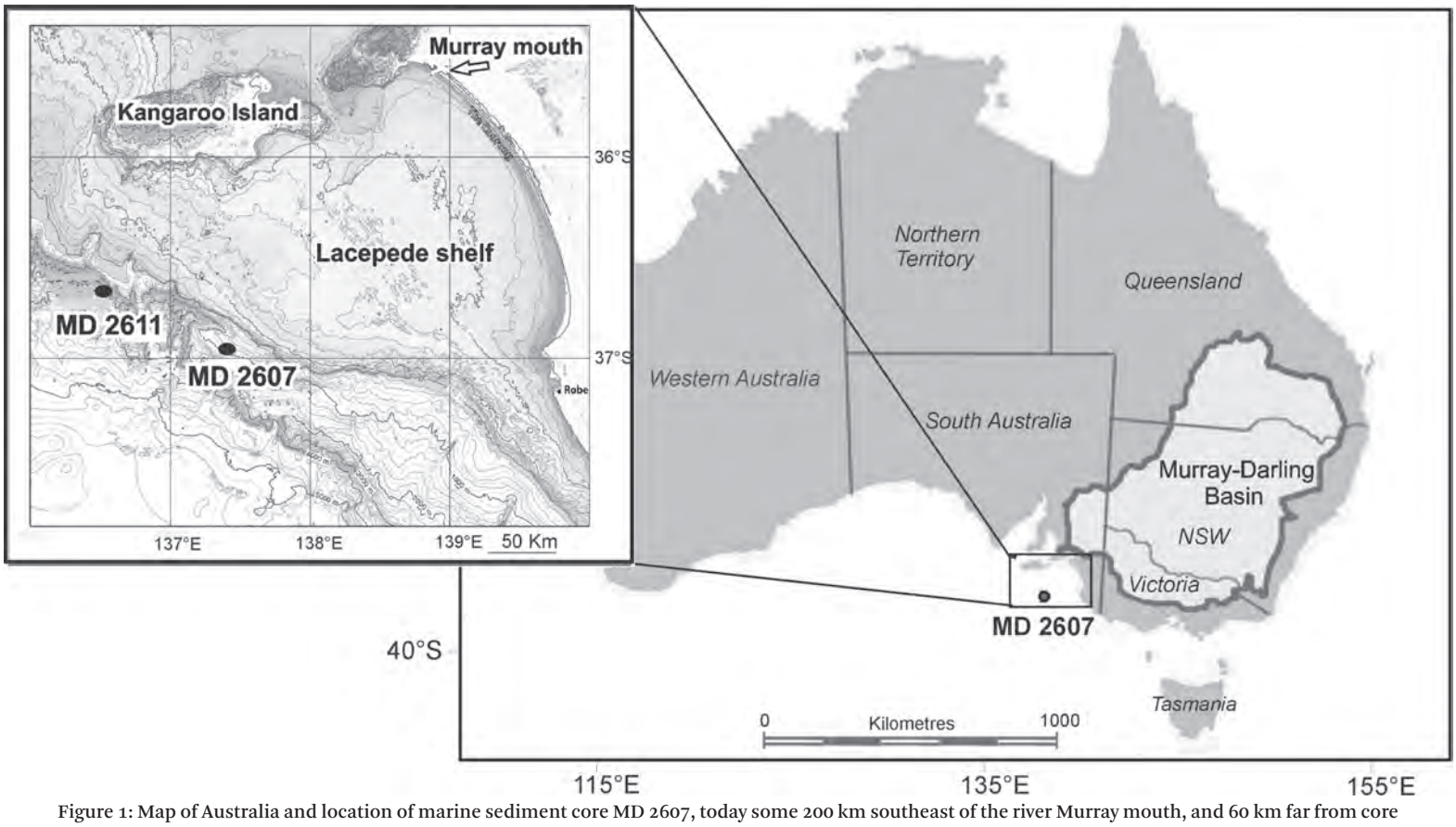

Figure 1: Map of Australia and location of marine sediment core MD 2607, today some 200 km southeast of the river Murray mouth, and 60 km far from core MD 2611. The Murray-Darling Basin, highlighted in light grey, covers much of the southeast Australian continent.

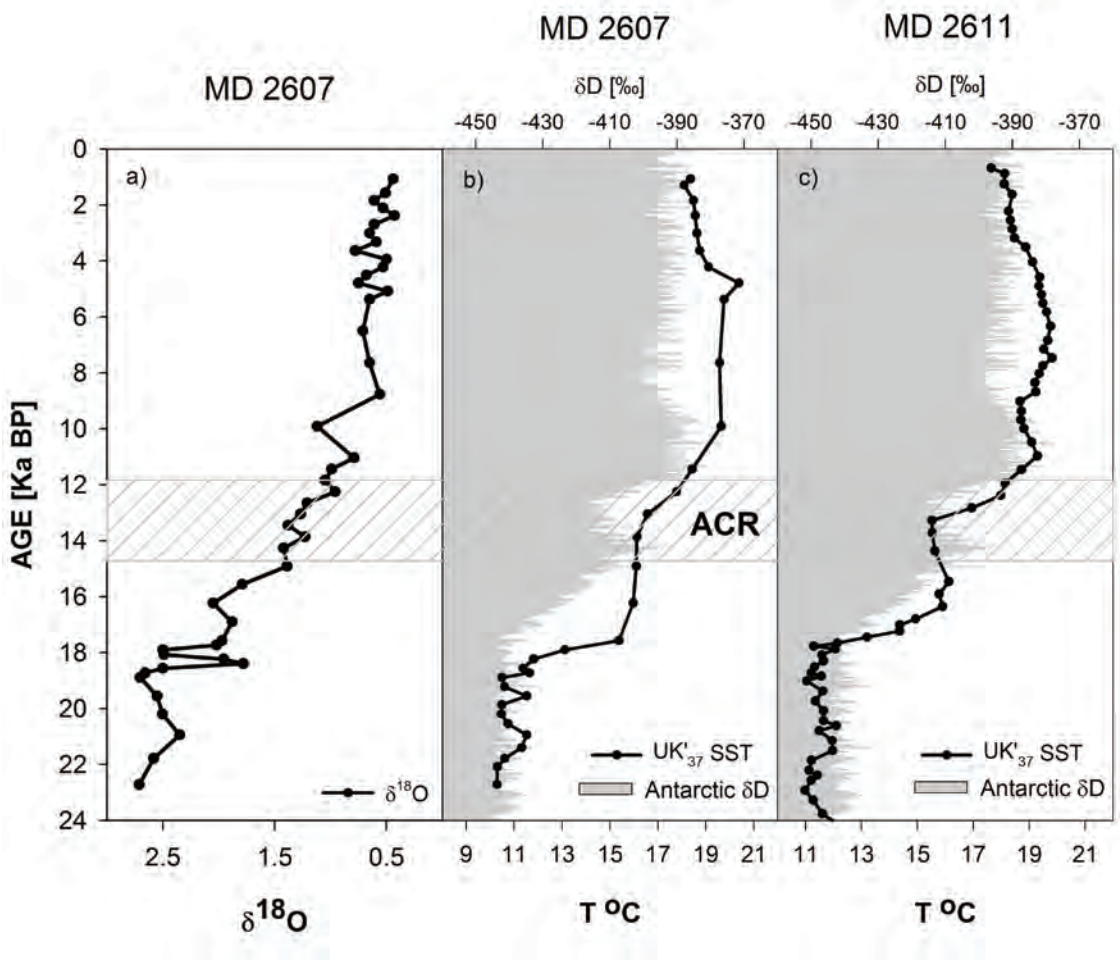

Figure 2: $\delta^{18}O$ profile of core MD2607, published in Gingele *et al.*, 2004 (a) together with the $U^{K'}_{37}$ SST profile of the same core (b) and the $U^{K'}_{37}$ SST profile of the nearby core MD2611, published in Calvo *et al.*, 2007 (c). The grey shaded area is the δD record from EPICA Dome C ice core (Jouzel *et al.*, 2007). ACR = Antarctic Cold Reversal.

Methods

The age model of the MD 2607 core was developed using OSL and ^{14}C dating. The ~33 m sediment core was sampled at 10 cm intervals down to a depth of 300 cm. The sediment samples were then freeze-dried, homogenised and extracted using an Automated Solvent Extractor (ASE 200, DIONEX; 100ºC and $7.6*10^6$ Pa with a mixture of dichloromethane: methanol [9:1, v:v]). After adding internal standards the extracts were separated using an Al_2O_3 pipette column into apolar, ketone and polar fractions. We used a range of organic proxies to reconstruct past variations in the marine environment and those on the continent. Past sea-surface temperatures (SST) are estimated using the $U^{K'}_{37}$ and TEX_{86}. The first one is a well established method based on the relative distribution of the long chain ketones produced by haptophyte algae (Brassel *et al.*, 1986). These compounds were analysed by Gas Chromatography (GC) – Hewlett Packard 6890) on a 50 m, silica column with 0.32 mm of diameter and coated with CP Sil-5 (thickness=0.12µm). The TEX_{86}, a relatively new method, was calculated based on relative abundance of Glycerol Dialkyl Glycerol Tetraethers (GDGT), compounds produced by Crenarchaeota (Schouten *et al.*, 2002). The GDGTs were analysed using an Agilent 1100 series high performance liquid chromatography (HPLC)/ mass spectrometer (MS) with a Prevail Cyano column (2.1x150 mm, 3µm). For the reconstruction of upwelling conditions, we used a newly-developed proxy based on the relative distribution of long chain 1,14- and 1,15-diols (Rampen *et al.*, 2008). The 1,14-diol is produced by *Proboscia* diatoms, algae that become dominant during the early upwelling season (Koning *et al.*, 2001). These compounds were analysed from the polar fraction using a ThermoFisher DSQ GC/MS operated in single ion mode monitoring ions of m/z 299, 313 and 327, with a dwell time of 100 ms and ionisation energy of 70 eV. Soil organic matter input in the marine environment was assessed using the Branched and Isoprenoid Tetraether (BIT) index. This index is a ratio between branched GDGTs produced by soil bacteria and crenarchaeol produced mainly by marine Crenarchaeota. The BIT was calculated using the method described by Hopmans *et al.* (2004) and analysed by HPLC/MS as described above. Finally, the distribution and isotopic composition of long chain *n*-alkanes derived from plant waxes recovered in the sediment core, were analysed to provide information on past vegetation changes in the catchment area of the Murray-Darling Basin. *N*-alkanes were analysed using a ThermoFisher Delta V isotope ratio monitoring - GC/MS and the weighted average

$\delta^{13}C$ of odd long chain n-alkanes (from C27 to C33) was calculated and used to estimate percentage of C4 grasses, assuming end-member values of -36‰ for C3-type vegetation and -21.5‰ for C4-type vegetation.

Discussion

The SST profiles from both $U^{K'}_{37}$ and TEX_{86} proxies are remarkably similar and suggest SSTs of 10-11°C at the Last Glacial Maximum and a warming of ~9°C until the Holocene thermal maximum at ~5 ka. This warming occurred in two steps, interrupted by a gradual cooling that started around 3 kyr before the Antarctic Cold Reversal. A cooling of 2°C, from ~5 ka until the most recent part of the core, is also well represented (Fig.2). Our results compare very well with a previous $U^{K'}_{37}$ SST record from an adjacent core taken some 60 km away (Calvo *et al*., 2007). The diol index, a proxy to estimate relative changes in upwelling intensity, showed that the Last Glacial Maximum in the region was characterised by low upwelling intensity (diol index ~0.3), whereas the present-day upwelling system (diol index ~0.5) came into existence after the Antarctic Cold Reversal, thus showing that the distribution of currents is an important factor controlling upwelling in the nearby canyons. The highest diol index values were recorded during the early-middle Holocene and range from 0.6 to 0.7. The BIT index showed higher values of soil organic matter input (~0.22) during the Last Glacial Maximum compared to present day (0.03). This is explained by the fact that sea level was ~ 120 m lower at that time (Hill *et al*., 2009), and therefore the river mouth was closer to the core site, resulting in increased influx of terrestrial material to the Murray Canyon marine sediments.
The *n*-alkane record shows an increase in the input of C4 plants from 50% during the Last Glacial Maximum to 70% after the deglaciation and a gradual decrease to 60% in the most recent part of the core, suggesting substantial changes in C3-C4 vegetation distribution. Alternatively, there was a change in the source area of the *n*-alkanes, since the terrestrial fraction of the core comprised relatively more fluvial input during Last Glacial Maximum, and relatively more dust input during the Holocene (Gingele *et al*., 2004; 2007).
Our results reveal substantial changes in climate, providing new information about the upwelling system and vegetation changes for southeast Australia. We are currently increasing the resolution of our proxy records covering the last 22 kyr and are extending these records to 200 ka ago. This work will provide an unprecedented record of climate variation for SE Australia.

References

- Bleys, E.J., Hunt, G.R. and Truscott, M., 1994. *Quaternary climate in Australia: a bibliography*. 2nd Edition. AGSO Record 1994/52.
- Brassel, S.C., Eglinton G., Marlowe I.T., Pflaumann U. and Sarnthein M., 1986. Molecular stratigraphy: a new tool for climatic assessment. *Nature* 320, 129-133.
- Calvo, E., Pelejero, C., De Deckker, P. and Logan, G.A., 2007. Antarctic deglacial pattern in a 30 kyr record of sea surface temperature offshore South Australia. *Geophysical Research Letters* 34, L13707.
- Gingele, F.X., De Deckker P. and Hillenbrand, C.D., 2004. Late Quaternary terrigenous sediments from the Murray Canyons area, offshore South Australia and their implications for sea level change, palaeoclimate and palaeodrainage of the Murray-Darling Basin. *Marine Geology* 212, 183-97.
- Gingele, F.X. and De Deckker P., 2005. Late Quaternary fluctuations of paleoproductivity in the Murray Canyons area, South Australian continental margin. *Palaeogeography, Palaeoclimatology, Palaeoecology* 220, 361-373.
- Gingele, F.X., De Deckker P. and Norman, M., 2007. Late Pleistocene and Holocene climate of SE Australia reconstructed from dust and river loads deposited offshore the River Murray Mouth. *Earth and Planetary Science Letters* 255, 257-272.
- Hill, P.J., De Deckker, P., von Der Borch, C. and Murray-Wallace, C.V., 2009. Ancestral Murray River on the Lacepede Shelf, southern Australia: Late Quaternary migrations of a major river outlet and strandline development. *Australian Journal of Earth Sciences* 56, 131-153.
- Hopmans, E.C., Weijers J.W.H., Schefuβ E., Herfort L., Sinninghe Damsté J.S. and Schouten, S., 2004. A novel proxy for terrestrial organic matter in sediments based on branched and isoprenoid tetraether lipids. *Earth and Planetary Science Letters* 224, 107-116.
- Jouzel, J., Masson-Delmotte V., Cattani O., Dreyfus G., Falourd S., Hoffmann G., Minster B., Nouet J., Barnola J.M., Chappellaz J., Fischer H., Gallet J.C., Johnsen S., Leuenberger M., Loulergue L., Luethi D., Oerter H., Parrenin F., Raisbeck G., Raynaud D., Schilt A., Schwander J., Selmo E., Souchez R., Spahni R., Stauffer B., Steffensen J.P., Stenni B., Stocker T.F., Tison J.L., Werner M., and Wolff E.W., 2007. Orbital and millennial Antarctic climate variability over the past 800,000 years. *Science* 317, 793-797.
- Kershaw, A.P., Bretherton S.C. and van der Kaars, S., 2007. A complete pollen record of the last 230 ka from Lynch's Crater, north-eastern Australia. *Palaeogeography, Palaeoclimatology, Palaeoecology* 251, 23-45.
- Koning, E., van Iperen, J.M., van Raaphorst, W., Helder, W., Brummer, G.-J.A. and van Weering, T.C.E., 2001. Selective preservation of upwelling-indicating diatoms in sediments off Somalia, NW Indian Ocean. *Deep-sea Research I* 48, 2473-2495.
- Rampen, S.W., Schouten, S., Koning, E., Brummer, G.A. and Sinninghe Damsté, J.S., 2008. A 90 ka upwelling record form the northwestern Indian Ocean using a novel long-chain diol index. *Earth and Planetary Science Letters* 276, 207-213.
- Schouten S., Hopmans E.C., Schefuβ E. and Sinninghe Damsté J.S., 2002. Distributional variations in marine crenarchaeotal membrane lipids: a new organic proxy for reconstructing ancient sea water temperatures? *Earth and Planetary Science Letters* 204, 265-274.

PAGES Meeting abstracts

Reconstructing pre-20th century temperature, rainfall and pressure for the Australian region using palaeo, documentary and early instrumental data

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While the suite of global and hemispheric reconstructions that have emerged during the last decade now form an important basis for the Intergovernmental Panel on Climate Change's (IPCC's) future scenario estimates, they still suffer from inadequate estimates of the range of Southern Hemisphere variability.

Reconstructions of Southern Hemisphere climate have suffered from a relative lack of data and research effort in comparison with the Northern Hemisphere. Given the importance of the 'Water Hemisphere' in driving and moderating many aspects of the global climate system, there is a clear need to consolidate palaeoclimate data in the Australian region.

This project directly targets a critical gap in global palaeoscience by assembling a range of pre-20th century palaeo, documentary and early instrumental data suitable for multi proxy temperature, rainfall and pressure reconstructions for the Australian region over the past 500 years. Data issues, methodology and results will be discussed in the context of an annually resolved, multi proxy pilot study.

Comparing regional climate reconstructions with independent reconstructions of the larger climate system (e.g. ENSO, SAM, IOD, PDO) is helpful for characterising the long-term stability of the dominant drivers of Southern Hemisphere climate variability in the Australian region. Results with our previously developed, annually resolved, ENSO reconstructions back to A.D.1525 are presented.

Given the large number of extreme climate events the Australian region has been experiencing recently, this research provides a timely context for understanding recently observed changes and an opportunity to constrain regional climate change projections using broader estimates of natural climate variability.

Postglacial Climate Evolution of the Southern Sub-equatorial Tropics From Speleothems in Flores, Indonesia.

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Modern climate in Indonesia is governed by the Australasian Summer Monsoon (ASM), which orchestrates rainfall variability and terrestrial productivity in northern Australia and Indonesian maritime continents. Gaining a clearer understanding of the dominant mechanisms that have influenced its variability since the last deglaciation has proven difficult because, until now, we have lacked precisely dated records of past monsoon behaviour. Radiometrically dated oxygen isotope and trace element data from two stalagmites in Flores (east Indonesia) provide the first high-resolution, terrestrial reconstruction of ASM behaviour covering the period 0 to 12.6 ka. The multi-proxy records are constrained by 62 TIMS and MC-ICP-MS U-series ages.

The isotope and trace element (i.e. Mg/Ca and Sr/Ca) records show that eustatic sea-level rise was the dominant climate forcing controlling ASM intensity during the early Holocene. Once sea-level had stabilised, Southern Hemisphere summer insolation became the dominant influence, whereby rainfall variability in the tropical west Pacific was driven by changes in convective intensity over the Australian continent associated with the migration of the ITCZ. This pattern of ASM variability is in phase with precipitation records from southern Brazil but anti-phased with East Asian summer monsoon intensity. Shorter-term (multi-decadal to centennial) increases in rainfall occur during periods of strong East Asian winter monsoon activity and match the timing of Northern Hemisphere ice-rafting events. Therefore, changes in ASM circulation over the past 12.6 ka reflect a combination of precession-controlled variations in external radiative forcing as well as internal climate dynamics associated with North Atlantic circulation and sea-level change.

Water isotope records of Australian palaeomonsoon dynamics over the last ~ 30 kyr: integrating speleothem reconstructions and GCM results

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We present high-resolution, uranium-series dated stable isotope records from multiple speleothems from southern Indonesia (8ºS, 120ºE) spanning the last ~30 kyr. Speleothem $\delta^{18}O$ variability at this site largely reflects changes in precipitation brought about by large-scale shifts in the position of ITCZ.

The speleothem $\delta^{18}O$ record shows pronounced variability over the last ~30 kyr and demonstrates distinct differences from late Quaternary speleothem-based climate reconstructions of the Northern Hemisphere (Borneo and China). In addition, fast-growing Indonesian stalagmites are near-annually banded and provide the opportunity for multi-proxy annual- and seasonal-scale rainfall $\delta^{18}O$ reconstructions during MIS3.

Although water isotope records provide some of the most extensive evidence of past climate change, interpreting their variability into climatic change requires applying a relationship between water isotopes and climate, usually inferred from modern variability. We improve this estimate for the relationship between water isotopes and climate through multiple simulations of past and present climate using the GISS ModelE-R, a fully coupled atmosphere-ocean GCM equipped with water isotope tracers. In addition, we tag water isotope variability due to alterations in source through the addition of 144 tracers that allow us to explicitly track the precipitation source distribution for individual sites.

Model results support the interpretation of isotopic variability in tropical speleothem records and allow a greater understanding of late Quaternary changes in precipitation. In southern Indonesia, speleothem $\delta^{18}O$ variability is caused by changes in local precipitation amount and shifts in oceanic source region through time.

Understanding ENSO dynamics through the exploration of past climates

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Historical reconstructions show that significant changes in ENSO characteristics took place during the Holocene. "Modern" El Niño variability began around 5-7,000 years ago, with There was a gradual strengthening of ENSO thereafter, with and a possible peak in variability around 1-2,000 years ago. Exploring these changes, using both data and models, provides a means of understanding ENSO dynamics.

Modelling studies to date have suggested a mechanism whereby changes in the Earth's orbital geometry explain the strengthening of ENSO over the Holocene. Decreasing summer insolation over the Asian landmass resulted in a weakening of the Asian monsoon system. This led to a weakening of the easterly trade winds in the western Pacific, making it easier for El Niño events to develop. To explore this hypothesised forcing mechanism, we use the CSIRO Mk3L climate system model to conduct a suite of simulations of the climate of the past 8,000 years.

We find that the model is able to reproduce the historical trends in ENSO variability. In the early Holocene, the easterly trade winds are amplified in the western Pacific during the northern autumn, consistent with an enhanced Asian monsoon. The stronger trade winds represent a barrier to the eastward propagation of westerly wind bursts, therefore inhibiting the onset of El Niño events. We find that the fundamental behaviour of ENSO remains unchanged, with the major change over the Holocene being the influence of the background state of the Pacific on the susceptibility of the ocean to the initiation of El Niño events.

AQUA conference field trip to the Coorong, South Australia

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Following the December 2008 AQUA conference in Victor Harbour, South Australia, and early on the Thursday morning, December 11, a band of somewhat weary Quaternary scientists filed onto the bus after a successful conference dinner the evening before. Spirits soon picked up however, as after hearing references to the Coorong, Lake Alexandrina and Lake Albert throughout the conference, we were excited to get a chance to finally see those sites. The region features a RAMSAR-listed wetland system formed at the mouth of the Murray River. There has been much controversy in recent years over appropriate management strategies for the area with the health of the wetlands in decline. The stretch of coastline between Victor Harbour and Kingston is also of great significance as a record of Quaternary sea level fluctuation. The area is characterised by a series of beach ridges running parallel with the modern shoreline. The ridges are fossil barrier dunes, formed by marine transgressions and regressions throughout the Quaternary and preserved through uplift, which is occurring at a rate of 0.07 mm/yr (Bourman et. al, 2000). The aim of the fieldtrip, led by John Cann and Patrick De Deckker, was to allow us to see the variety of unique environments in the Coorong area, and provide a background to their formation and history, and issues associated with their management.

A stop at Meningie allowed us to see Lake Albert. Water levels were so low that the jetty was left high and dry (Figure 1). The reduction in water levels in Lake Albert, in conjunction with reduced flows in the Murray and Darling Rivers, has led to an increase in salinity. The salinity of lake was tasted by a dedicated few who can attest to the highly saline conditions (Figure 2). Lake Albert is connected to Lake Alexandrina by a narrow channel to the north, and is not directly connected to the Coorong. However it is believed that a link between Lake Albert and the Coorong may previously have existed (Bourman et. al, 2000).

Figure 1. Jetty at Lake Albert, Meningie.

Figure 2. Testing the salinity of Lake Albert—the old fashioned way

A series of barrages were constructed between the Coorong and Lake Alexandrina in the early 20th century. The barrages act to reduce the influence of tidal marine water and thus maintain water quality within the lakes so that the water can be used for irrigation. Due to reduction in flows in the Murray River, however, water quality within Lakes Alexandrina and Albert has greatly declined in recent years. This has led to debate over the best method of managing the system, with suggestions of opening up the barrages and allowing tidal activity to flush the lake out. A number of palaeoecological studies have investigated past environmental conditions within the Coorong and Lakes Alexandrina and Albert prior to modification of the system by irrigation and barrage construction. Diatom assemblages from Lake Alexandrina suggest that prior to river regulation, relatively freshwater conditions dominated (Fluin et. al, 2007). The provision of environmental flows and water quality of the Murray River is therefore identified

Figure 3. The Coorong. The active barrier dune, the Younghusband Peninsula, can be seen in the background.

as crucial to address declining water quality in Lakes Alexandrina and Albert (Fluin et. al, 2007).

The next stop we had the chance to see what we'd all been waiting for – the Coorong. The Coorong is a shallow coastal lake that has formed between the Younghusband Peninsula (the present coastal barrier dune) and the last interglacial barrier dune (Figure 3). The Coorong runs parallel with the shoreline for over 100 km. The present barrier dune lies on an older, calcreted dune associated with sea levels during the interstadials of 80 – 100 ka (Bourman, 2000). Water quality in the Coorong has also declined in recent years. Due to the presence of the barrages separating the Coorong, there is little input of freshwater from the Murray River and Lake Alexandrina. The Murray Mouth, located in the northern part of the Coorong, is regularly inundated by sediment from the Southern Ocean, and at present is kept open only by dredging. Palaeocological studies using diatoms found that prior to Murray River regulation, the Coorong was a marine environment strongly influenced by tidal activity (Fluin et. al, 2007). Maintaining a link between the Coorong and the Southern Ocean by keeping the Murray Mouth open is therefore of greatest importance in addressing the ecological health of the Coorong (Fluin et. al, 2007).

The surface hydrology of this region is influenced by the presence of the fossil barrier dune ridges, so that the dominant flow of surface water is parallel with the coast. A series of ephemeral lakes have formed in the depressions between fossil ridges. The next few stops were related to the salt lakes and active calcrete formation associated with these ephemeral lakes. The majority of ephemeral lakes within the Coorong region lie within 1 m of mean sea level, and are filled by rainfall and fresh and saline groundwaters (De Deckker and Geddes, 1980). Winter-dominated rainfall in the region leads to inundation of the lakes, and in summer the lakes dry out through evaporation and lowering of the groundwater table. As evaporation occurs, salts precipitate, forming crusts (Figure 4). The site of Halite Lake was used for commercial salt production early in the 20th century (Figure 5). The salt lakes visited on the fieldtrip, Magrath Flat and Halite Lake, were pink in colour due to the presence of *Dunallelia halia* micro-algae. The sediments underlying these salt crusts were black due to the presence of sulphate-reducing bacteria. Early European settlers in this region thought the black colouring of this sediment was indicative of the presence of oil, and attempts to drill for oil were made near Halite Lake.

The sediments of the Coorong region consist largely of skeletal and fossiliferous calcareous sediments associated with a coastal barrier complex (Belperio et. al, 1995). In some ephemeral lakes near Salt Creek, the calcite mud is lithified to form dolomite or aragonite caps above carbonate muds (Wright, 2007). The mineralogy of the caps is controlled by biochemical activity; dolomite forms where sulphate-reducing bacteria completely remove sulphate, and aragonite where some sulphate remains (Wright, 2007). Desiccation cracks can often be found in these caps, through which calcite muds have been extruded and later lithified (Figure 6).

The fieldtrip to the Coorong region was a fun and informative day and a fantastic way to wrap up a great conference. Patrick De Deckker and John Cann were full of useful information and interesting stories of the history of the region, and how scientific understanding of its formation has developed through time. I'd like to pass on my thanks to everyone involved in the organisation and running of the AQUA conference at Victor Harbour.

References

- Belperio, A.P., Murray-Wallace, C.V. and Cann, J.H., 1995. The last interglacial shoreline in southern Australia: morphostratigraphic variations in a temperate carbonate setting. *Quaternary InternationalI,* 26: 7-19.
- Bourman, R.P., Murray-Wallace, C.V., Belperio, A.P. and Harvey, N., 2000. Rapid coastal geomorphic change in the River Murray Estuary of Australia. *Marine Geology,* 170: 141-168.
- De Deckker, P. and Geddes, M.C., 1980. Seasonal Fauna of Ephemeral Saline Lakes near the Coorong Lagoon, South Australia. *Australian Journal of Marine and Freshwater Research,* 31: 677-699.
- Fluin, J., Gell, P., Haynes, D., Tibby, J. and Hancock, G., 2007. Palaeolimnological evidence for the independent evolution of neighbouring terminal lakes, the Murray Darling Basin, Australia. *Hydrobiologia*, 591: 117-134.
- Wright, D.T., 2007. The role of sulphate-reducing bacteria and cyanobacteria in dolomite formation in distal ephemeral lakes of the Coorong region, South Australia. *Sedimentary Geology*, 126: 147-157.

Figure 4. Salt precipitation on the fenceline in a salt lake at Magrath Flat.

Figure 5. Halite Lake

Figure 6. Desiccation cracks in calcrete.

Australian Archaeological Association

Noosa, Queensland
3 - 6 December 2008

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The Australian Archaeological Association (AAA) annual conference for 2008 was held in tropical Noosa, Queensland from the 3-6th December 2008 at the Australis Noosa Lakes Resort. It was organised by the University of Queensland's School of Social Science and convened by Chris Clarkson, Pat Faulkner and Andy Fairbairn. Large numbers of delegates attended, including those from academic teaching and research, student bodies, professional archaeology, Indigenous and Torres Strait Islander delegations, international delegations and cultural heritage management. Without an overarching theme directing the conference, there emerged a diversity of presentations on a wide range of engaging topics. Sessions were broken into archaeological sub-disciplines such as: historical archaeology, consultancy and cultural heritage management, in addition to those that addressed specialist areas such as microscopy, lithic technology and archaeobotany. Others examined how transects can be made across traditional disciplinary divides with several sessions showcasing the international work of Australian archaeologists.

The conference opened with sessions on how to cross traditional disciplinary barriers and began with the session *Engaging the future.* This examined how the discipline can address scientific debates associated with environmentally-based societal stresses through using a unique 'time perspective' (Mate *et al.,* 2008). The session to follow – *Land and sea: Natural resource management versus cultural heritage management* – was one of the larger sessions. The papers explored how natural resource management and cultural heritage management interact in the context of Indigenous land and sea management programs across Australia. The next session was an historical archaeology session entitled *Current research and future directions for historical archaeology in Australia.* Its aim was to establish how archaeological research on historical sites in Australia can address broader questions and future directions. The next several session topics included specialist areas such as rock art research and lithic technology. *New rock art research in Australia, the Pacific and Southeast Asia* examined how archaeological research in Australia can be positioned into the Pacific and Southeast Asian regional contexts. *Lithic technology in focus: Technological and microsopic analyses of lithic assemblages* presented research outlining the potential for combining many forms of analysis with an aim to expand the information garnered from the study of lithic assemblages. The final session on Day 1 – *The Archaeology of the recent past* – focused on the emerging trend that uses archaeological evidence of Indigenous connection to country post European-contact. The Annual General Meeting for AAA was held following the sessions on Day 1, and the Executive Committee was carried over from 2008.

The second day began with the examination of *The uses of technology in contemporary archaeological practice,* whereby a variety of presentations outlined the limitations and usefulness of technologies such as

Figure 1. Noosa, Hibiscus and Frangipanis. (Photos: Daniel Rosendahl and Mirani Litster)

Figure 2. Val Attenbrow presenting Sean Ulm with his lifetime membership. (Photo: Daniel Rosendahl)

Geographical Information Systems (GIS) and remote sensing – from both archaeological and cultural heritage management perspectives. A session on *Archaeobotanical studies in China, Southeast Asia and Australia* included papers on the integral role of archaeobotany within archaeology as the broader discipline. The anticipated contentious session on *Current issues in archaeology: Murujuga (the Burrup Peninsula)* followed. However, it was decidedly less heated than the topic would suggest. Nonetheless, several presentations highlighted the mining industry pressure and interest placed on this significant cultural area. There were also many presentations on consulting archaeology in the *AACAI session: Consulting, research and heritage management.* These aimed to showcase current research arising from consulting projects, heritage management practice and the impacts new legislation have had on the consulting industry. The poster session followed, and in the evening Peter Hiscock presented the 'cinematic image and origin of the Indiana Jones character' (Mate *et al*., 2008). Afterwards *The Mummy's Shroud* (1967) was screened.

Beyond borders and boundaries: Research projects beyond Sahul opened Day 3, with a vast range of research presented by Australian archaeologists practising internationally, which highlighted topics ranging from the *Islamic landscapes of southern Spain* to *Optically stimulated luminescence dating of pottery in the Galapagos Islands.* Following this, Paul Bahn presented a well received Keynote Address – *What happened on Rapa Nui?* His address examined the recent studies on Easter Island, looking particularly at the conflicting and controversial arguments over the Island's environmental destruction. And the final session for the conference – *Australian studies in taphonomy and archaeofaunas: A session in honour of the late Su Solomon* – celebrated Su Solomon's contribution to the discipline's knowledge of taphonomy and the study of animal bones in Australia.

The annual awards ceremony saw Sean Ulm receive life membership to the association for his outstanding contribution and commitment to AAA over recent years (Figure 2). Peter Hiscock was awarded the John Mulvaney Book Award for the excellence of his publication *The Archaeology of Ancient Australia* (2008). Annie Ross received the Bruce Vietch award for outstanding Indigenous engagement throughout the year. Pat Faulkner was recipient of the University Of Waikato Radiocarbon Dating Prize for the project *Patterns of predation: Human exploitation of Anadara granosa, Blue Mud Bay, North Australia.* The Laila Haglund Prize for Excellency in Consultancy was awarded to Oliver Macgregor, Alex Mackay, Phil Hughes and Marjorie Sullivan, and the best overall paper of the conference was awarded to Gail Robertson, Val Attenbrow and Peter Hiscock for *The multiplicity of uses of Australian backed artefacts*.

Following the awards presentation, the conference dinner was held at the Australis Noosa Lakes Resort. It was a resounding success, with good food and free flow of alcohol fuelling high spirits and intelligent conversation (Figures 3, 4 and 5). In the very early hours of the morning many of the delegates unofficially closed the conference in a predictably ceremonious fashion - in the pool in various stages of undress.

The post conference field trip involved an all day boat cruise of the Noosa Everglades and Cooloola region (Figure 6). This included commentary by Steve Nichols, Karen Murphy and Ian McNiven on the history and archaeology of the early timber industry on Lake Cootharaba and the Indigenous archaeology and history of the Cooloola region.

The AAA 2008 conference at Noosa was a huge success, with an assorted range of pertinent and engaging topics and presenters, whilst also enjoying the largest number of conference delegates at any AAA thus far.

Figure 3. Sean Ulm and Bryce Barker at the conference dinner. (Photo: Daniel Rosendahl)

The next annual conference will be held by Flinders University in Adelaide from the 11-14 December 2009. The theme will be 'Old Guard, New Guard', which will examine the future for archaeology in Australia over the next decade. For further information about the Australian Archaeological Association and future conferences see: http://www.australianarchaeologicalassociation.com.au

References

- Hiscock, P. 2008. *The archaeology of ancient Australia.* Routledge, New York.
- Mate, G., Murphy, K. and Franklin, N. (eds). 2008. *Australian Archaeological Association Annual Conference – Programme and Abstracts.* Queensland Museum, Brisbane.

Figure 4. Kylie Lower, Louise Holt, Danielle Gorke and Victoria Baylem at the conference dinner. (Photo: Victoria Baylem)

Figure 5. Elena Piotto, Helene Tomkins, Merle O'Rourke, Ian Lilley and Jane Skippington at the conference dinner. (Photo: Daniel Rosendahl)

Figure 6. Noosa River. (Photo: Mirani Litster)

AQUA at FASTS Science meets Parliament (SmP)

Parliament House, Canberra, 16th to 17th March 2009

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We were encouraged to see the Government as users of our science, not just funders. We as scientists play a crucial role in informing the community and politicians are an integral part of this.

Tuesday morning began with an overview by Bradley Smith (Executive Director, FASTS) on ways to interact with politicians to maximise outcomes. During the day we heard from many experts who interact with politicians on a regular basis. The first panel was composed of Sophie Morris (Australian Financial Review), Jane Nicholls (past advisor to Senator Kim Carr) and Michael Green (Head of Infrastructure). The deadlines they need to meet are extraordinary. Sophie receives hundreds of headline emails per day from media release sites and must quickly select one as her story and move on it. Sophie's advice for scientists when sending media releases is to make it relevant and catchy, and to phrase it as a story. Another tip was to call

Photo: Scientists meet Parliament dinner at Parliament House on Tuesday 17 March 2009. Pictured are (left-right): Dr John Veron, coral reef researcher, Professor Henk Heijnis, ANSTO, Professor John Dodson, ANSTO, Mike Siers, ANSTO, Dr Suzanne Hollins, ANSTO, Dr Patrick Moss, University of Queensland and AQUA President, and Rachael Skinner, University of Adelaide.

journalists in the morning, not after 4pm when they are trying to meet their deadlines (although this is not as relevant with internet news). Jane Nicholls discussed her typical day, starting early at 7 am, with the day often formed by the latest media buzz and responses needing to be ready by noon. Michael Green is responsible for a team of 20. His team is responsible for completing briefings by 10:30 am, so again an early start! The take home message was that all three panelists rely on scientists to get reliable and rapid expert opinions on daily issues. At noon we had an address by Senator Eric Abetz and the following day lunch at the 'Press club' with an address by Senator Kim Carr, both spoke on the topic of recent government activities in science and innovation. It was very interesting to hear the different approaches various parties had to the same topic. The hint for us is that it's all in the phrasing. Tuesday finished up with dinner at Parliament house, where the informal discussions with various politicians were very enlightening. Politicians had to have one eye on the alarm for the parliamentary sessions, which required them to race off to vote on various issues. I'm not sure I could deal with that kind of stress!

I had two meetings with politicians on Wednesday. The first, with Mark Butler (MP for Port Adelaide), was shared with fellow scientists Rachel Caruso (solar cells) and Chris Green (Co_2 capture). Mark was genuinely interested in my research on the long term condition and health of Lake Alexandrina and the Murray River. My afternoon meeting was with Jamie Briggs (MP for Mayo) and fellow scientists Sandra McLaren (thermal regime of Australia and long term history of the Murray Basin) and Alyson Miller (Stroke prevention research). My study area of the lower Murray basin lakes is located within Jamie Briggs' electorate (Mayo), and thus the current environmental and socio-economic dilemmas are of major concern to him. I used the "less is more" approach in both meetings. I discussed the answers I have so far to the top three questions on stakeholders' minds, namely: Were the Lower Lakes fresh over their long-term history? Were marine incursions common into Lake Alexandrina? Was there enough flow to keep the Murray Mouth open prior to river regulation and abstraction? Preliminary results suggest yes, no (marine incursions were very rare) and yes (there probably was connectivity with the marine environment in the Goolwa Channel) respectively.

We were encouraged by FASTS to follow up on promises made during the meetings. I invited the MP's I met with to visit our lab group. Jamie Briggs visited our lab group "Environmental Reconstruction and Monitoring Research" on 6th April at the University of Adelaide. SmP not only gave not only me but also my colleagues the opportunity to communicate our science to parliament. I was pleased to represent the AQUA community along with Patrick Moss and Henk Heijnis. I recommend being involved in this event, as it is a fantastic opportunity for professional development, networking with scientists outside your normal field and building relationships with politicians. Politicians can actually take your recommendations on board and get the message across to the wider community. Wise advice given when dealing with parliamentarians was to be straightforward and honest, and don't overstate your findings. The suggested approach was to inform rather than whinge or demand funding. It was also enlightening to be reminded that Parliamentarians are approachable, likeable people who work very hard!

Southern Connections and Convergences: climate, environment and cultural adaptations in the cool temperate southern hemisphere

The Environmental Futures Network Working Group On Southern Connections And Convergences*

*Left to right: Atholl Anderson (ANU, retired), Ian Smith (Otago), Lisa Matisoo-Smith (Auckland), Richard Cosgrove (La Trobe), Simon Haberle (ANU), Nigel Prickett (Auckland Museum), Jose Miguel Ramirez (Valparaiso), Michael Fletcher (Melbourne), Marcus Vandergoes (GNS), Richard Walter (Otago). Punga Lodge, Little Oneroa, Waiheke Is., New Zealand (25-27 November 2008).

In the quiet village of Little Oneroa on Waiheke Island, just a 30 minute ferry ride from Auckland, a group of 10 scholars from southern Australia, New Zealand and southern Chile met over 3 days (25-27 November 2008) to explore similarities and differences of environmental and cultural histories across a 'southern circumpolar zone' (Figure 1, ~40-50°S). The possibility that domestic fowl (*Gallus gallus*) was transported prehistorically to southern Chile from East Polynesia (Storey *et al*., 2007, 2008; Gongora *et al*. 2008a, 2008b), together with some artefactual and linguistic data implicating New Zealand, indicates some potential connections. In addition, the influence of similar climates (e.g. "roaring forties") and ecologies (e.g. cool temperate rainforest dominated by *Nothofagus*) on convergent adaptations in each region may be revealed in the archaeologies. To what extent do historical connections versus adaptive convergences explain perceived similarities in ecology or culture between isolated landmasses?

The evidence now available from archaeology, palaeoecology and ethnohistory in each region revealed a surprising series of historical connections and adaptive convergences that warrant further exploration and explanation. Four major issues where identified as key to understanding cultural change in the southern

cool temperate zone. (1) interactions between climate-biodiversity-people on different time scales, (2) prehistoric human settlement, (3) human interaction with the southern ocean, and (4) late dispersal of commensals.

Interactions between climate-biodiversity-people
Research into the interactions between climate-biodiversity-people will focus on outlining biodiversity trends in the southern mid-latitudes - the zone of westerly circulation - and the cool temperate rainforest zones. While there is a remarkable similarity between regional climate histories and the response of natural ecosystems to climate change, the timing and nature of human impact on these environments is very different. In Tasmania human occupation, the use of fire and maintenance of open vegetation may have persisted for the last 38 cal kyr BP. In southern Chile (14 cal kyr BP) and New Zealand (0.7 cal kyr BP) the impact of people is much shorter. Comparing palaeoecological records of environmental change will provide the basis for assessing human population dynamics and resource abundance in relation to climate change. This will include the long term population changes in response to large scale climate shifts such as glacial and interglacial changes and also responses to sub-millennial scale climate shifts (e.g., ENSO and Little Ice Age).

Prehistoric human settlement
The archaeological sequences are best known from Tasmania and southern New Zealand. These are at the extremes of human settlement in the Pacific; Tasmania in the late Pleistocene during the initial expansion of modern humans and southern New Zealand at the termination of Polynesian dispersal. They are also at very different scales of resolution. Tasmanian archaeology spans 38,000 years and is written largely at the millennial scale, while the archaeology of southern New Zealand is entirely within 7-800 years. As might be expected, narratives of human prehistory relate more easily to patterns of long-term climate change in Tasmania than in New Zealand, where extensive deforestation and faunal extinction near the beginning of the sequence loom large in explanatory models.

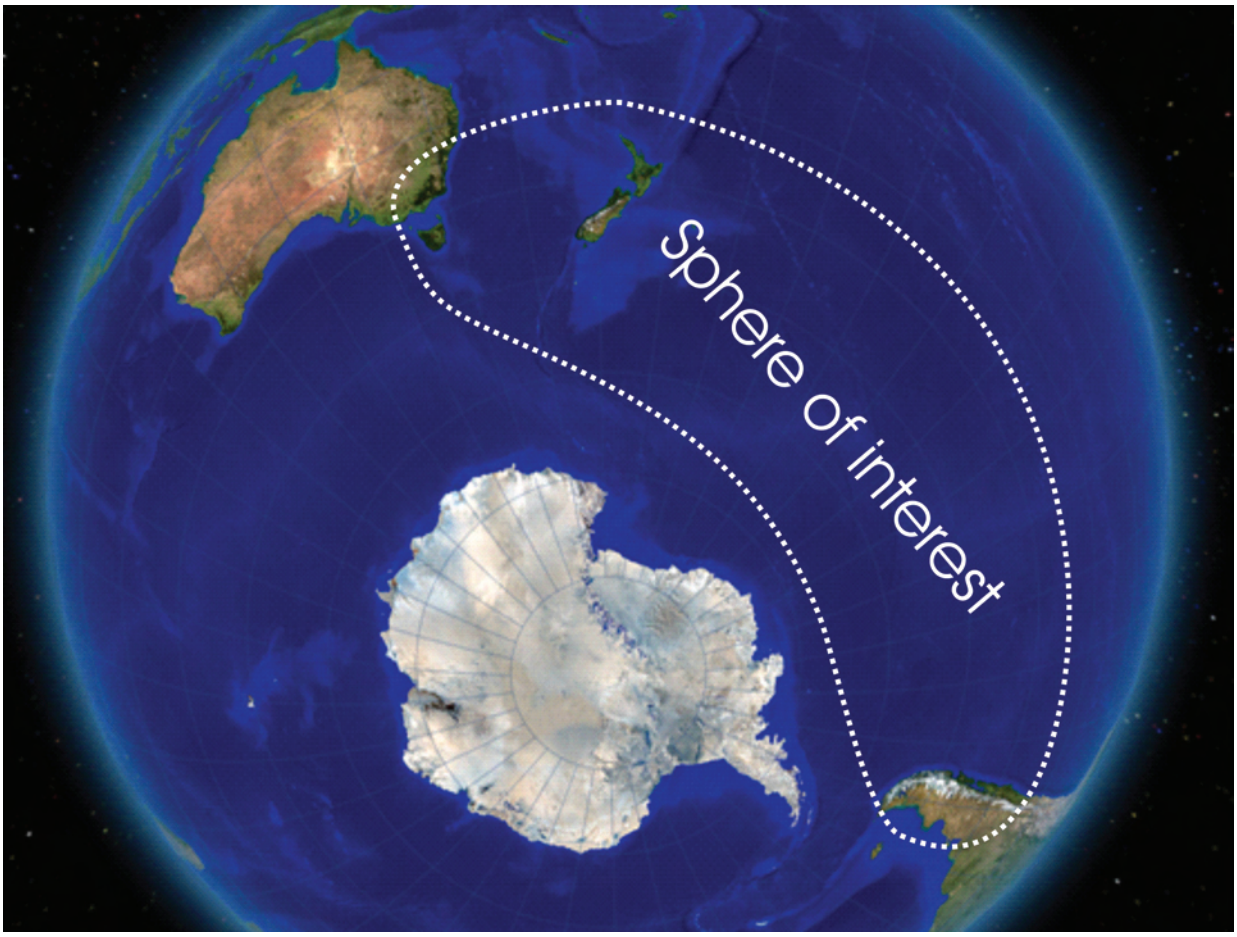

Figure 1. Sphere of interest for the Southern Connections and Convergences group.

However, we are aware that even minor climatic changes in southern New Zealand, as represented by the LIA, might have been influential in changing settlement patterns and, conversely, that sequences of high resolution in Tasmania, as at West Point, might disclose patterns and suggest explanations at that scale which are more similar to models for southern New Zealand prehistory.

The sequence from Parmerpar Meethaner in central Tasmania provides one overarching model for Tasmanian prehistory. Early occupation pulses occur at 38-31 cal kyr BP and between 22-12.2 cal kyr BP (peaking at 16.8 cal kyr BP), periods of occupancy that correspond with late Pleistocene climatic ameliorations and other temporal correlates from southwest and southeast Tasmania (Figure 2 below). In southern New Zealand, lying south of the limits of Polynesian agriculture, there is no such single-site sequence covering the prehistoric era and adaptive responses are read from the settlement patterns. The early loss of moa plus deforestation in Canterbury and north Otago and the relative unfavourable coast for subsistence led to increased settlement about Foveaux Strait. where seals and other marine resources were abundant, but continuing regional resource depression led to decline of coastal villages in Otago and effective abandonment of Foveaux Strait. Only late in prehistory was permanent settlement re-established. The relative roles of anthropogenic resource depression and climate change in settlement pattern decisions remain to be explored further.

Between the long Tasmanian and short southern New Zealand prehistories is the 14,000 year occupation of southern South America. This involved terminal exploitation of terrestrial megafauna, amongst a wide range of animal and plant resources, as at Monte Verde

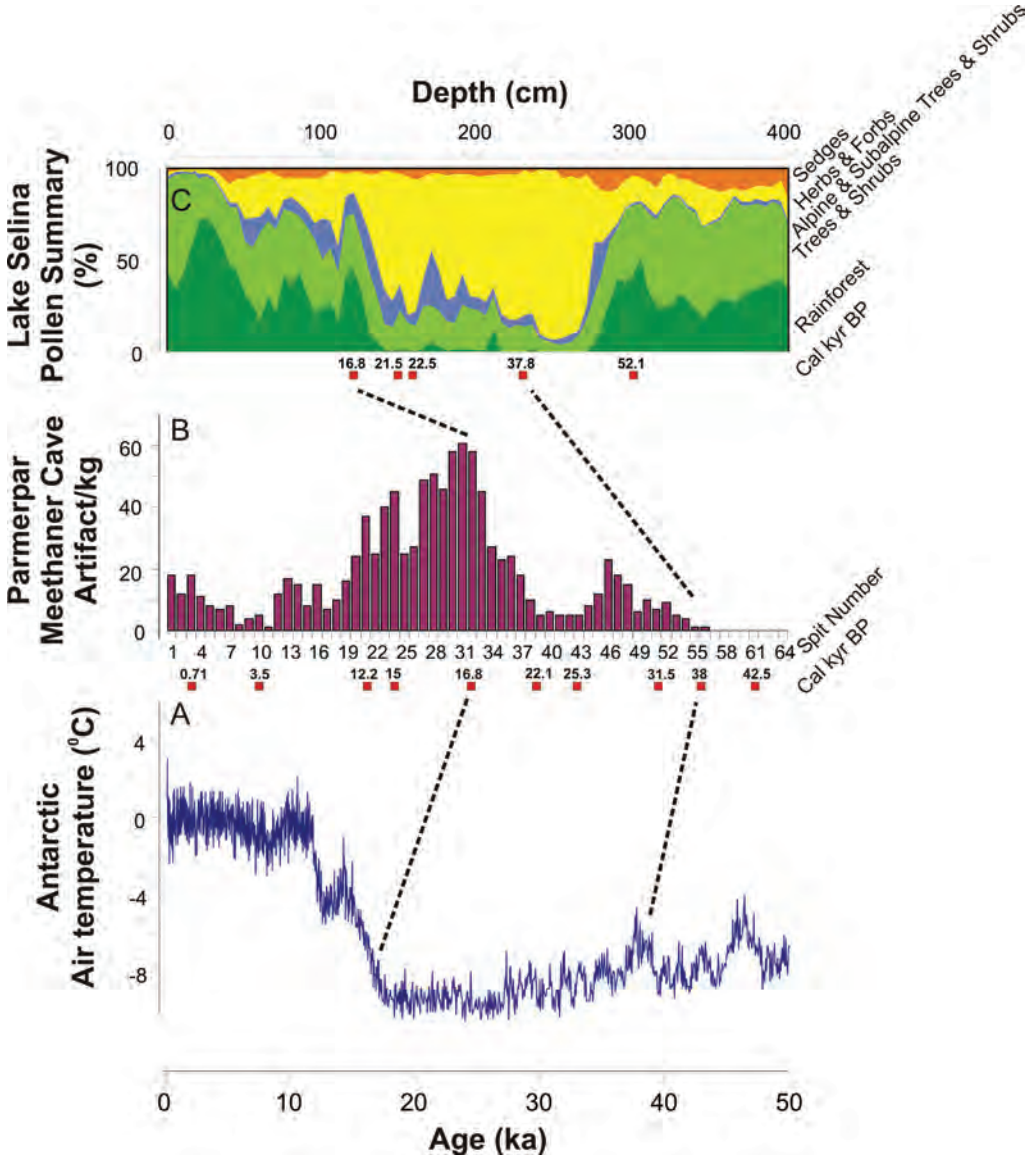

Figure 2. Proxy records for the last 50,000 years illustrating the coupling between warming in Antarctica, forest expansion in western Tasmania and human occupation pulses in the central Tasmania. (A) Air temperature over Antarctica derived from a deuterium proxy from the Epica Dome C ice core on the EDC1 timescale (Jouzel *et al.* 2007); (B) Discard rate of artefacts (per kg) of sediment per spit in square A of the excavation at Parmerpar Meethaner Cave indicating human population densities in central Tasmania (Cosgrove 1995); (C) Pollen summary diagram from Lake Selina (Colhoun *et al.* 1999). The black dashed lines indicate the beginnings of occupation pulses in Tasmania corresponding to periods of expanding forest and warming temperatures.

in Chile, and a later focus upon coastal resources during the Archaic era. During the late Holocene settlement expanded into the forested interior prior to the arrival of agriculture and ceramics around 2500 cal yr BP. More details of this settlement sequence and its relationship to environmental dynamics is being sought.

Human interaction with the southern ocean
The first people to reach the ocean littoral in each of the three study areas benefitted from the enormous productivity of the southern ocean through exploitation of marine mammals, birds, fish and shellfish. Despite this, their impact on the ocean's resources was minimal, with only localised extirpations (eg northern NZ seal populations, sea bird nesting colonies e.g. *Megadyptes waitaha*).

Beginning in the late 18th century, there was a change in human interaction from subsistence to entrepreneurial imperatives in exploitation of the littoral and pelagic zones. But for coastal hunting and fishing this initiated exploration of the immensely productive, largest single biological zone on the planet, the southern ocean. Pelagic whaling, shore whaling and sealing for skins and oil were driven by northern hemisphere capitalism, industrialisation and urbanisation – especially the need for machine and lighting oil. Sealing and shore whaling were short-lived, but pelagic whaling persisted throughout the 19th century and still continues.

The new form of exploitation led to entirely new contacts between the southern lands in question. People, plants and animals were moved across the southern ocean. Shore whaling and sealing had important social, cultural and economic outcomes for the people and regions where it took place, leading significantly to a new wave of settlement and the emergence of mixed race populations. The wider exploitation of the southern ocean led to profound and continuing changes. Pelagic whaling led to substantial reductions in the populations of large whales and subsequent industrial exploitation of the southern ocean has led to further simplification of the food chain.

Late dispersal of commensals
The introduction and translocation of a range of non-native species to Pacific Islands began nearly 20,000 years ago but humans and their commensal plants and animals arrived in the more southern regions of Polynesia only within in the last 1000 years. Polynesian agriculture was transplanted successfully to northern New Zealand (albeit with a reduced range of commensals) but reached the limits of tolerance just south of Cook Strait.

The presence of the sweet potato (*Ipomoea batatas*) and bottle gourd (*Lagenaria siceraria*) throughout Polynesia provides evidence of prehistoric contact between Polynesia and South America. Recent evidence for pre-Columbian chicken introductions to the coast of south central Chile, though still debated, suggests that exchanges were made in both directions. We do not yet understand the extent, specific timing and full impact of these prehistoric interactions on the populations and environments concerned. If chickens were introduced to South America, were other Pacific commensal animals as well? When were they introduced and were there multiple introductions? Did Polynesians settle on some of the small off-shore islands of south central Chile, as some human osteological data suggest, or were there merely brief encounters?

European arrival in the southern Pacific also resulted in the introduction of a range of plant and animal species which significantly affected social interactions, economies and environments in the region. The introduction of potatoes and pigs to southern New Zealand, for example, dramatically increased the economic productivity of this otherwise marginal environment. Maori adopted several varieties of potatoes and have maintained production of many of these which are now often referred to as "Maori potatoes". Where did these varieties originate? Are they evidence of later South American connections? Further archaeological and genetic research is planned to investigate these issues.

This meeting was funded through the ARC Environmental Futures Network (http://www.adelaide.edu.au/efn/). A follow up meeting will be held at the next VI Southern Connections Congress to be held Bariloche, Argentina on February 15-19, 2010 (http://www.sccongress2010.com.ar/php/index.php).

References

- Colhoun, E.A, *et al.* (1999) Late Pleistocene vegetation and climate history of Lake Selina, western Tasmania. *Quaternary International* 57-58: 5-23.
- Cosgrove, R. (1995) Late Pleistocene behavioural variation and time trends: a case from Tasmania. *Archaeology in Oceania* 30: 83-104.
- Gongora J, *et al.* (2008a) Indo-European and Asian origins for Chilean and Pacific chickens revealed by mtDNA. *Proc Natl Acad Sci USA* 105: 10308–10313.
- Gongora J, *et al.* (2008b) Reply to Storey *et al.*: More DNA and dating studies needed for ancient El Arenal-1 chickens. *Proc Natl Acad Sci USA* 105: E100
- Jouzel, J., *et al.* (2007) Orbital and Millennial Antarctic Climate Variability over the Past 800,000 Years. *Science*, 317: 793-797.
- Storey A.A, *et al.* (2007) Radiocarbon and DNA evidence for a pre-Columbian introduction of Polynesian chickens to Chile. *Proc Natl Acad Sci USA* 104: 10335–10339.
- Storey A.A., *et al.* (2008) Pre-Columbian chickens, dates, isotopes, and mtDNA. *Proc Natl Acad Sci USA* 105: E99

ARC outcomes for 2009

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The ARC grant outcomes released in mid October 2008 for project funding commencing in 2009 produced another reasonably good result for Quaternary studies in Australia. 20 Discovery projects were funded amounting to $6.9 million, which is down slightly on the levels of the last 2 years (Figure 1; 2007-8 average is 25 grants and $10.5 million). Archaeology related projects did particularly well with 15 Discovery projects and all of the postdocs and fellowships awarded (with the exception of 1 APDI and a Linkage International Fellowship) being in this category. "Galactic Archaeology" even gets a gearnsey in this years round, though I don't include this in the comparison below. A total of 6 APD's, 1 QEII, 1 ARF, 1 APDI and 2 APAI were awarded. Congratulations to all those who where successful.

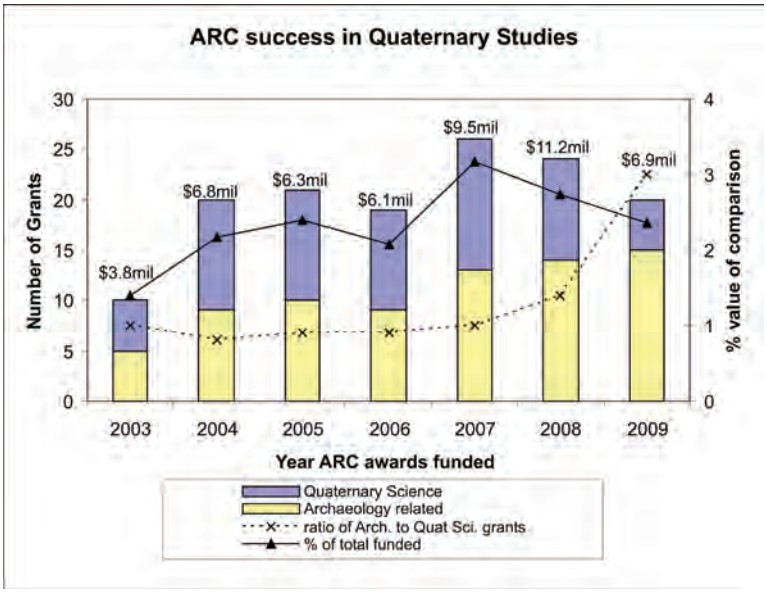


Figure 1. Comparison of yearly outcomes for successful ARC Discovery projects.

THE UNIVERSITY OF QUEENSLAND

Dr CJ Clarkson; Dr MD Petraglia; Dr NL Boivin
Assessing lithic evidence for the impact of the Toba super eruption (74,000 years ago) on long term cultural, biological and ecological histories on the Indian subcontinent
2009: $ 59,000; 2010: $57,000; 2011: $54,000
Primary RFCD: ANTHROPOLOGY

Dr AS Fairbairn
Agriculture and the Late Bronze Age collapse of the Hittite Empire
2009: $61,090; 2010: $52,050; 2011: $37,130
Primary RFCD: ARCHAEOLOGY AND PREHISTORY

Dr MI Weisler; A/Prof J Zhao
Voyaging, Trade and the Development of Ancient Complex Societies in East Polynesia: An Interdisciplinary Approach
2009: $105,000; 2010 $80,000; 2011: $120,000
Primary RFCD: ARCHAEOLOGY AND PREHISTORY

A/Prof J Zhao; Prof AR Chivas; Dr H Zhou (Linkage International Fellowship)
Continental temperature and rainfall change during past global warming - a multiproxy approach involving clumped isotopes in speleothems
2009: $ 82,000
Primary RFCD: ATMOSPHERIC SCIENCES
Collaborating Countr: China

THE UNIVERSITY OF SYDNEY

Prof J Bland Hawthorn; Prof KC Freeman; Dr SC Keller; Prof M Asplund
Galactic Archaeology: a Challenge for the Cold Dark Matter Paradigm
2009: $170,000; 2010: $170,000; 2011: $170,000
Primary RFCD: ASTRONOMICAL SCIENCES

Dr TE Doelman; Dr P Jia
Crossing Borders: The Use and Distribution of Volcanic Glass Artefacts in Northeast Asia
2009: $95,000; 2010: $40,000
Primary RFCD: ARCHAEOLOGY AND PREHISTORY

Dr M Fillios (APD)
The Taphonomy of Waterhole Faunal Death Assemblages: A model for Archaeological Contexts in the Australian Semi Arid Zone
2009: $78,978; 2010: $95,000; 2011: $95,000; 2012: $67,000
Primary RFCD: ARCHAEOLOGY AND PREHISTORY

Dr MJ Hendrickson (APD); Dr C Pottier; Prof Dr HJ Leisen; Dr DE Cook; Dr Q Hua
Industries of Angkor: Material Production and the Decline of the Khmer Empire (11th to 15th centuries CE)
2009: $128,000; 2010: $108,000; 2011: $93,000
Primary RFCD: ARCHAEOLOGY AND PREHISTORY

Dr D O'Reilly; Dr RA Armstrong; Dr KM Domett; Dr LG Shewan; Prof CF Higham; Prof R Chhem; Dr N Beavan Athfield; Dr C Pottier
History in their bones: A diachronic, bioarchaeological study of diet, mobility and social organisation from Cambodian skeletal assemblages
2009: $74,000; 2010: $56,000; 2011: $ 24,000
Primary RFCD: ARCHAEOLOGY AND PREHISTORY

Prof DT Potts (APF)
From village to empire in the Zagros highlands: Archaeological investigations at Tol e Nurabad (Fars Province, Iran)
2009: $104,000; 2010: $104,000; 2011: $104,000; 2012: $78,590; 2013: $104,000
Primary RFCD: ARCHAEOLOGY AND PREHISTORY

Dr R Torrence; Mrs NA Kononenko (APD); Dr EA Carter
Valuing Stones: obsidian stemmed tools in the creation of social complexity in Papua New Guinea
2009: $149,000; 2010: $100,000; 2011: $101,000; 2012: $107,000
Primary RFCD: ARCHAEOLOGY AND PREHISTORY

THE UNIVERSITY OF NEW SOUTH WALES

Dr SW Wroe; Dr DK Curnoe
The mechanics of being human
2009: $60,000; 2010: $50,000; 2011: $60,000
Primary RFCD: GEOLOGY

Dr S Hand; Prof M Archer; Mr SA Hocknull; Mr TH Worthy (APDI); A/Prof JD Woodhead; Dr DI Cendon; A/Prof J Zhao; Dr IT Graham; Dr JD Scanlon; Dr GJ Price; Prof AR Chivas (Linkage Project including 1 APDI Award)
Environmental change in northern Cenozoic Australia: a multidisciplinary approach
2009: $ 300,000; 2010: $ 300,000; 2011: $ 300,000
Primary RFCD: GEOLOGY
Collaborating/Partner Organisation(s): Xstrata Copper North Queensland; Queensland Museum; Outback at Isa; Mount Isa City Council

Dr SA Ross; Dr SE Connor; Dr AI Herries; Dr G Burgers; Dr I Iliev; Ms A Sobotkova; Dr K Rabadjiev
Cultural change in its environmental context: exploring, interpreting, and managing archaeologically rich, large-scale cultural landscapes in the Mediterranean Basin
2009: $ 70,000; 2010: $ 20,837; 2011: $ 26,267
Primary RFCD: ARCHAEOLOGY AND PREHISTORY
Collaborating/Partner Organisation(s): Royal Netherlands Institute in Rome; Historical Museum, Yambol

UNIVERSITY OF WOLLONGONG

Dr K Szabo (QEII)
The cutting edge: Investigating the use of shell as a raw material by Australasian hominins
2009: $132,701; 2010: $127,000; 2011: $163,119; 2012: $117,220; 2013: $120,769
Primary RFCD: ARCHAEOLOGY AND PREHISTORY

THE AUSTRALIAN NATIONAL UNIVERSITY

Prof AJ Anderson; Dr SG Haberle; Dr GR Clark
Crossing the Green Sea: maritime mobility, trans oceanic interaction and remote island colonisation in the tropical Indian Ocean
2009: $ 279,000; 2010: $ 150,000; 2011: $ 200,000
Primary RFCD: ARCHAEOLOGY AND PREHISTORY

Dr SG Haberle; Dr RF Cosgrove; Dr PT Moss; Prof JF O'Connell; Ms A Ferrier
Light islands in a sea of dark rainforest: Human influence on fire, climate and biodiversity in the Australian tropics.
2009: $ 156,423; 2010: $ 120,291; 2011: $ 166,971
Primary RFCD: ARCHAEOLOGY AND PREHISTORY

Ms H Hung (APD); Prof PS Bellwood
A study of ancient jade trading networks in prehistoric southern China and Southeast Asia, 3000 BC to AD 500
2009: $ 114,000; 2010: $ 100,000; 2011: $ 100,000
Primary RFCD: ARCHAEOLOGY AND PREHISTORY

Prof MT McCulloch; Dr JA Trotter; Prof RB Dunbar
Ocean Acidification in a Rapidly Increasing CO_2 World
2009: $ 230,000; 2010: $ 160,000; 2011: $ 160,000; 2012: $ 120,000
Primary RFCD: OCEANOGRAPHY

Dr MJ Prebble (APD)
Tracking 3000 years of agricultural adaptation to the resource poor, climate sensitive and remote Solomon Islands using biomarkers and palaeoecology
2009: $ 113,000; 2010: $ 117,000; 2011: $ 78,591
Primary RFCD: ARCHAEOLOGY AND PREHISTORY

THE UNIVERSITY OF MELBOURNE

A/Prof D Phillips; Dr M Honda
The Cosmogenic 21Ne Exposure Dating Method: Calibration for Application to Volcanic Chronology, Landscape Evolution and Palaeo Climate Change
2009: $75,000; 2010: $60,000; 2011: $60,000

Primary RFCD: GEOLOGY

A/Prof JD Woodhead; Dr S Frisia; Dr A Blyth
Ancient weather stations of Australia: charting a continent's descent into aridity and its ecological consequences
2009: $ 100,000; 2010: $60,000; 2011: $60,000
Primary RFCD: ATMOSPHERIC SCIENCES

MONASH UNIVERSITY

Dr LM Brady (APD)
The Kaurareg Archaeological Project, south Western Torres Strait, Australia
2009: $ 110,000; 2010: $100,000; 2011: $110,000; 2012: $58,943
Primary RFCD: ARCHAEOLOGY AND PREHISTORY

LA TROBE UNIVERSITY

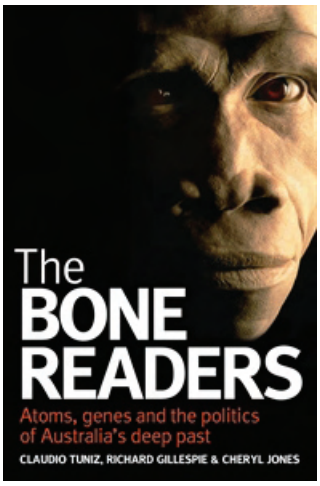
Prof TA Murray; Dr CH Smith (Linkage Project including 1 APAI Award)
A Historical archaeology of the Commonwealth Block 1850-1950
2009: $ 94,000; 2010: $ 94,000; 2011: $ 26,140
Primary RFCD: ARCHAEOLOGY AND PREHISTORY
Collaborating/Partner Organisation(s): Museum Victoria

THE UNIVERSITY OF ADELAIDE

Prof A Cooper; Dr KP Aplin; Prof SC Donnellan
Phylogeography, evolution and taxonomy of humanity's greatest pest, Rattus rattus: Epidemiological, archaeological and conservation implications
2009: $ 130,000; 2010: $ 130,000; 2011: $ 130,000
Primary RFCD: ZOOLOGY

THE FLINDERS UNIVERSITY OF SOUTH AUSTRALIA

A/Prof M Staniforth (Linkage Project including 1 APAI Award)
The South Australian Historical and Maritime Archaeology Management Project
2009: $ 26,140; 2010: $ 26,140; 2011: $ 26,140
Primary RFCD: ARCHAEOLOGY AND PREHISTORY
Collaborating/Partner Organisation(s): SA Maritime Museum; Department of Environment and Heritage; AHMS Pty Ltd



The Bone Readers: Atoms, genes and the politics of Australia's deep past
Claudio Tuniz, Richard Gillespie and Cheryl Jones
Allen and Unwin 2009
ISBN 978 1 74114 728 5
Paperback $AU35.00

The origins of Australian Aboriginal people have intrigued scientists for well over a century. This interest was sparked following the publication of Darwin's *Origin of Species* in 1859. A resulting effect was 'Social Darwinism'. Evolution in its many forms became important in understanding our place in the ladder of a Westernised 'civilised' world. For reasons of perceived social superiority, Australian Aboriginals were placed at the bottom rung.

This book set outs to provide an historical account of some of the main themes of bioarchaeological scientific enquiry in Australia: from where did the Aboriginal people of Australia originate; when and by what means did they arrive here and how did they interact with the Australian environment? The first few chapters look at the numerous dating techniques without being text book-like and discuss the prominent Lake Mungo skeletons, the oldest archaeological sites in Australia and sea levels through time. This sets up a coherent interpretation of early habitation in Australia. The following chapters cover the controversial topic on what triggered the extinction of Australian megafauna, which contains some entertaining reading. Further controversy can be found in the section on the origins of Aboriginal Australians, where multi-regionalist debate and DNA research is discussed. Although the focus is on Aboriginal origins, the Flores Hobbit and Neanderthals are included in this history book. The last chapter discusses briefly the repatriation of Aboriginal remains and the book ends back where it began, at Lake Mungo.

The central theme of this book is Aboriginal people of the past. The book does not claim to present the views of modern Aboriginals, but does attempt to provide some voices to juxtapose the science. Whilst many people may generalize about the beliefs of modern Aboriginals, this book does not. For example, the authors show that not all Aboriginal people mistrust science. This is refreshing to read. The authors also prefer to let the Aboriginal speakers do the talking, and try not to provide any 'editorial' comments on Aboriginal opinions.

The chapters that examine the study of megafaunal extinction in Australia are the most controversial. Social politics and perceptions have influenced archaeological thought in Australia. Scientists who study this topic have been divided into two camps. Perhaps erroneously, there are negative connotations for both. Firstly, any scientist who dares to suggest that the ancestors of today's Aboriginal people are in any way responsible for the extinction of Australian megafauna is labelled imperialist and racist. Then there is the group that declares that Aboriginal people are one with the natural world and would never adversely affect their environment. These scientists are declared to be idealistic and patronising, and are determined to stifle scientific research and debate. Whilst these are gross generalisations, emotion has not been able to be kept out of the debate. In their treatment of the megafaunal extinction issue they set out their argument well. The data from extinct bird shells and associated stable isotope data, undisturbed megafaunal fossil sites, environmental data, and global extinction patterns are used as evidence to determine what initiated the widespread extinctions. Their conclusions are well argued.

The exchanges between the personalities involved in a spiteful debate on megafaunal extinction make for interesting reading. It is clearly stated that one of the authors has been involved in these fiery exchanges and that this history is not being written by an impartial bystander. Nevertheless, without many of these quotes and some honest comments, this insightful history of Australian research would have remained in the shadows.

Whilst reading this book, I perceived some competitive spirit with archaeologists. I was perplexed by the quote "*Many archaeologists worry about losing prehistory completely to these practitioners of the arcane sciences – 'the timelords'*" (p11). Not being aware of this attitude amongst fellow archaeologists, I asked Dr Claudio Tuniz about this statement. He pointed out that archaeologists, such as the late Rhys Jones, had 'expressed such concerns'. I would hope that as archaeological research becomes increasingly multi-disciplinary, this attitude will disappear. Studies of past people can only benefit from this.

The history of Australian archaeology is accurately depicted. It briefly describes the division of male-dominated Palaeolithic prehistory and female-dominated Holocene prehistory. It also highlights the apparent men's club whose members are contesting to have the oldest site or new species of hominid.

The book identifies many issues that archaeologists recognise, but have done little to rectify. These include repeatedly reporting old and inaccurate radiocarbon dates, not being adequately trained to identify charcoal from decayed matter in soil. In addition, it appears that some long running debates have stagnated and may never be resolved. An example would be the robust/gracile Palaeolithic Aboriginal skeleton debate and the associated interpretations. This debate is based on a limited amount of skeletal material and we are unable to resolve it based on current evidence.

Although it can also be argued that our identification of hominid species around the world is based on limited information, yet is readily accepted. '*The Bone Readers'* shows how little we have progressed in the understanding of Aboriginal origins and the occupation of Australia. It also highlights to the reviewer that the same questions that were asked 100 years ago are still being asked today and are still valued. Who are the Aboriginal people? How different are they from non-Aboriginals? We need to ask whether or not these questions are still valuable, especially seen in the light of the 'subjects' not being interested in the answer.
It is also interesting to note that whilst the book is called '*The Bone Readers'*, the title may be misleading for many. For example, my interpretation of the term 'bone reader' is a literal one. A bone reader is a person who can pick up a bone and 'read' the markings on the bone. They can then interpret those markings. That may be the role of a physical anthropologist or a zooarchaeologist. After asking Dr Claudio Tuniz why they chose the name '*The Bone Readers'*, he pointed out that bones can be 'read' by a wider range of scientists. This book challenges us to think outside our own microcosm to understand that bones can be 'read' in many different ways.
This book provokes many significant questions. Will (or should) archaeology and other associated disciplines be confined to research that is valuable only to the Aboriginal community or 'subjects'? Can we justify doing research on the ancestors, if the descendants care little for the results? Will science ever be true to itself if politics refuses to interfere?
This well researched book is skilfully written both for layman and expert alike. It is written in an evocative style, which enables the reader to visualise the settings easily. Dr Claudio Tuniz says that he and his fellow authors spent many years researching this book, as well as interviewing around 100 people. This is quite evident and the authors should be commended for it. The ability of the authors to simplify and explain complex matters and methodologies is outstanding. This book will be useful to the general public, but should also be read by students and practitioners of archaeology and physical anthropology, who would not only gain insight into their fields, but will also get a lesson in how to make science comprehensible.

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Late Pleistocene subsistence in Sahul: case studies from Australia

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The aim of this thesis is to investigate the faunal assemblages recovered in Pleistocene sites across Sahul. The findings from three case studies are used as a springboard for discussion about the generalisations which have been offered in recent decades about the diet and foraging strategies of populations of modern humans. The information gleaned about hunting strategies from Pleistocene sites in Sahul seeks to describe fundamental and essential differences in the prey hunting strategies of late Pleistocene populations from other parts of the world.

The analysis of the faunal remains from three distinct regions in Greater Australia discusses the assemblages in more detail and identifies patterns which suggest that the modern humans who colonised this continent, whether in the tropics or in the temperate zone, consistently approached their subsistence in the same broad-based way. Faunal assemblages recovered from sites across Australia indicate that medium to large macropods were the most common prey found in Pleistocene sites. The assemblages also indicate that an abundance of smaller prey from diverse habitats including inland aquatic resources was systematically exploited from the beginning of human occupation. The findings contrast with those from Europe and southwest Asia, which suggest that in the Northern Hemisphere, latitudinal variation had a significant role in subsistence behaviour.

Much more detailed data from Pleistocene faunal assemblages is needed before a more accurate pattern of subsistence behaviour in Sahul can be constructed. More detailed analysis on faunal assemblages recovered from Pleistocene sites in Greater Australia focussing on butchery practices and seasonal resource exploitation patterns would provide a clearer picture of human subsistence strategies.

A Palaeoenvironmental History of the Paroo and Warrego Regions, Australia: a Multi-proxy, Multi-site Approach

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The records of environmental change in Australia's arid zone can be greatly enriched by employing a multi-proxy approach and landscape-scale analysis. This research uses these tools to construct a palaeoenvironmental history of the Paroo/Warrego Region. While the Region's flow regimes and water balances are characterised by medium-term (decadal) variability, its hydrological records are inadequately brief. Subsequently, land and water management decisions are based on short term data, risking irreversible damage, desertification or loss of diversity. A better understanding of this highly dynamic landscape can thus improve the land and resource management outcomes.

While dating was constrained by a lack of funds, the Paroo/Warrego history reconstructed from fluvial and aeolian deposits correlated well with events recorded from other inland regions of the Australian continent. In summary, this new research provided evidence of high lake water levels prior to the Last Glacial. The extreme aridity at the onset of Last Glacial caused long term drying of the lakes and mobilisation of the red sand dunes. In latter stages of the glacial phase the aridity gave way to periodic fluctuations between flood and drought events that probably lasted until 16 000 - 14 000 BP. The new climatic regime resulted in formation of gypsum lunettes, and later, following reduction in gypsum supply, clay lunettes. The orientation of red sand dunes and lunettes indicates a more northerly extent of the westerlies than in modern times.

Around the late Pleistocene-early Holocene boundary the climate became more stable and wetter, but still somewhat drier than during the pre-Last Glacial lacustrine phase. As a result, the region's lakes reverted to a permanent and semi-permanent status. A strong aridity signal, comparable to the semi-regular droughts of the Last Glacial, was recorded in the Paroo/Warrego lakes during the late 1890s-1940s period of below average rainfall. It was followed by 50 years of wetter conditions with two extremely wet phases in the 1950s and the 1970s. Finally, the most recent records suggest a new drying trend.

The semi-arid vegetation appears to have adapted to climate variability, with herbs and grasses expanding with the onset of wet conditions before being replaced by Chenopodiaceae as the landscape started to dry. The fresher lake basins and water courses were likely to provide refuge during prolonged arid phases and dispersal foci during intervening wetter periods, thus enabling greater flexibility in response to changes and enhancing resilience. The European land use interfered with the natural cycles and balances, leading to decrease in ground cover, suppression of fire, increase in runoff and catchment erosion, acceleration of sediment accumulation rates in wetlands, resulting in decline of their water holding capacity, and expansion of woody vegetation.

The research improved the processing protocols, reference databases, and transfer of methods to enable greater sample processing efficiency and improve results. The use of multiple proxies (including biotic and abiotic components) and sites, as well as different depositional features, provided access to a broader picture of environmental change than was previously possible. It also facilitated multi-scale resolution, allowing discrimination between localised responses of individual lakes and regional trends. The full value of this research will come from informing natural resource managers, whose actions will shape the future landscapes of the Paroo and Warrego Region.

A digital copy of this thesis is available from the NOVA database (http://hdl.handle.net/1959.13/33470)

‘Before white man come…’ - The archaeology of mounded use and lithic technology at Carag Carag, North Central Victoria

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Lithic artefact and cultural mound distribution of a discrete area in north-central Victoria has been studied to indicate the type of activities that took place there pre- and post-contact by Aboriginal inhabitants. Furthermore, detailed lithic analysis was undertaken to understand how or whether activity area patterning has occurred, the possible antiquity of the site’s cultural deposits and chronology of occupation. Microenvironmental variations at Amaroo were tested to see what affect this had on deposition of material in terms of activity area patterning and taphonomy.

Amaroo also fits into archaeological research into semi-arid climate and wetland ecology, and human adaptation to these environmental factors. Studying mound and lithic archaeological remains helps us to understand the factors that led to specific adaptations in these types of environments, and to discover whether changes in the climate and environment of the area can be tracked through the types of cultural features at Amaroo.

The use of mounds at Amaroo appears to be both a cultural and environmental phenomenon that cannot be accurately dated. They were used pre- and post-contact near Amaroo, but there is little evidence that they were used much in modern times. There is a death of lithic material on mounds, but much of the mound material has been brought in by water movement. A complex taphonomic affect is therefore cited for lithic distribution on mounds.

Lithic analysis shows a reliance on smaller tools that may be explained by mobility patterns of groups using the site, influenced by the distance travelled to obtain raw stone sources and the availability of resources at Amaroo. Flaked and ground-stone technologies show that occupation ranged through part of the Holocene. Modern use of the site is supported by artefact analysis and ethnohistorical accounts.

Silcrete and the Outer City: investigating the patterns of raw material use at Bend Road, Victoria

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Bend Road is an open prehistoric Indigenous site located in Keysborough, an outer eastern suburb of Melbourne. Excavations undertaken at this site by La Trobe University in 2006 revealed several phases of occupation occurring between ca 35,000 BP up until the time of European contact. The majority of the lithic artefacts recovered from this site are composed of silcrete. Although the closest silcrete source in relation to this site is situated within 5-10km, the silcrete artefacts discarded at the Bend Road site were not originally procured from this area. This thesis sets out to investigate the abundance and distribution of slicrete sources across the Victorian landscape in the hope of attributing the Bend Road material to one or several of these sources.

To investigate the distribution of silcrete sources across the landscape, data were obtained from several sources which included archaeological survey and a review of the Victorian Aboriginal Heritage Register. The evidence obtained from these data indicates that there is a disparity in the distribution of silcrete sources between the western and eastern areas of greater Melbourne. To facilitate comparison of the Bend Road material to potential silcret sources, a classification system based on silcrete micro-morphology and colour was established. The classification system revealed that several distinct groups of silcrete occur in the assemblages. Further analysis performed on the silcrete artefacts has established that there are patterns of silcrete use occurring through time. This thesis considers the implications of these patterns and how they may be used to address questions regarding the organisational behaviours employed by prehistoric groups.

The Study of Faunal Assemblages from Open Sites in the Willandra Lakes: A case study from locality 969660

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Despite the wealth of archaeological sites located in the Lake Mungo region, the nature of settlement and subsistence activities of Aboriginal people during the Pleistocene remains poorly understood. Some study has been carried out to faunal material at Lake Mungo, however, to date, very little has been published on the subject. The following thesis details the results of a taphonomic study carried out over two field seasons in 2007 and 2008 on a series of five bone scatters in the Willandra regions of New South Wales.

The study area, blowout 969660, is located on the Lake Mungo lunette within the Willandra Lakes World Heritage Region. The data from five animal bone scatters is used to develop criteria for distinguishing between modern and ancient bone, and cultural and non-cultural bone accumulations. The date from blowout 969660 is used to make several preliminary inferences about the subsistence activities of people in this locality during the late Pleistocene. The results of this study show that contrary to common belief, useful information can be gathered from open sites such as those in the Willandra regions. Extending this study area in the future will provide greater insight into a wider range of subsistence activities.

Rocks in a Box: As assessment of unprovenanced artefact collections from the Willandra Lakes World Heritage Area

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The issue of artefacts being returned to institutions across Australia is problematic for the mangers of these ‘collections’, who need to deal with storage and potential uses for these artefacts. This also presents a challenge for archaeology, as these collections represent artefacts removed from their contexts by unprofessional means. This thesis investigates the potential of two

of these unprovenanced chipped stone collections from Lake Mungo National Park, part of the Willandra Lakes World Heritage Area: The Visitor's Collection and the Waugh Collection. The typological characteristics of the artefacts are described and the potential of each assemblage for education or display purposes is explored, suggesting that unprovenanced artefact collections do have potential uses for the institutions that receive them.

On Long-Term Climate Studies Using a Coupled General Circulation Model

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Coupled atmosphere-ocean general circulation models are the simplest models which are capable of simulating both the variability which occurs within each component of the climate system, and the variability which arises from the interactions between them. Only recently has it become computationally feasible to use coupled general circulation models to study climate variability and change on timescales of $O(10^4)$ years and longer. Flux adjustments are often employed to maintain a control climate that is both stable and realistic; however, the magnitude of the adjustments represents a source of concern.

This study employs the CSIRO Mk3L climate system model, a low-resolution coupled atmosphere-sea ice-ocean general circulation model. The atmospheric and oceanic components are spun up independently; the resulting atmospheric simulation is realistic, while the deep ocean is too cold, too fresh and too buoyant. The spin-up runs provide the initial conditions for the coupled model, which is used to conduct a 1400-year control simulation for pre-industrial conditions. After some initial adjustment, the simulated climate experiences minimal drift. The dominant mode of internal variability is found to exhibit the same spatial structure and correlations as the observed El Niño-Southern Oscillation phenomenon.

The ability of Mk3L to simulate the climate of the mid-Holocene is evaluated. It correctly simulates increased summer temperatures at northern mid-latitudes, and cooling in the tropics. However, it is unable to capture some of the regional-scale features of the mid-Holocene climate, with the precipitation over northern Africa being deficient. The model simulates a ~13% reduction in the strength of El Niño, a much smaller decrease than that implied by the palaeoclimate record.

A 1400-year transient simulation is then conducted, in which the atmospheric CO_2 concentration is stabilised at three times the pre-industrial value. The transient simulation exhibits a reduction in the rate of North Atlantic Deep Water formation, followed by its gradual recovery, and a cessation of Antarctic Bottom Water formation. The global-mean surface air temperature warms 2.7°C upon a trebling of CO_2, and 5.3°C by the end of the simulation.

A number of modifications to the spin-up procedure for the ocean model are evaluated. A phase shift in the prescribed sea surface temperatures and salinities is found to reduce the phase lag between the model and observations, and to lead to a reduction in the magnitude of the diagnosed flux adjustments. When this spin-up run is used to initialise the coupled model, the reduced flux adjustments are found to have negligible impact upon the nature of the internal variability. While the flux adjustments are not found to have any *direct* influence upon the response of the model to external forcing, they are found to have an *indirect* influence via their effect upon the rate of drift within the control simulation.

An iterative spin-up technique is also developed, whereby the response of the ocean model is used to derive a set of *effective* surface tracers. These result in a much more realistic vertical density profile within the ocean. The coupled model exhibits slightly increased internal variability, with reduced convection within the ocean. There is a slightly greater surface warming in response to an increase in the atmospheric CO_2 concentration, with the reduced convection resulting in slower penetration of the surface warming to depth.

Palaeolimnology as a management tool for Australian aquatic ecosystems

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Exploitation of land and water resources during the last 200 years has led to the degradation of many Australian aquatic environments. As a result, present day management often focuses on developing strategies to reverse or contain these environmental impacts. However, a lack of long term data on pre-impact conditions in many aquatic environments makes it difficult to define management goals and assess if management regimes have been successful.

This Thesis uses a palaeolimnological approach, based on the development of diatom transfer functions, to investigate human impacts on two contrasting aquatic environments and to determine baseline conditions and the direction, rate and nature of environmental changes.

At Lake King, coastal southeast Australia (37° 50'S, 148° 00'E) a 120 cm long sediment core was collected in order to investigate changes in nutrient status, salinity and the occurrence of nuisance algal blooms. First a reference dataset was constructed consisting of 81 sites of surface sediment diatoms sampled from lakes of different nutrient status and salinity to develop transfer functions. Application of these transfer functions to diatom assemblages in the core enabled the reconstruction of past phosphate concentrations and salinity (based on diatom-phosphate and –salinity transfer functions). The core was dated using ^{210}Pb and additional analyses were carried out on chlorophyll *a*, total sedimentary carbon, nitrogen and sulphur content and particle size. Collectively these analyses revealed a shift from a brackish to marine diatom flora after construction of a permanent entrance in 1889. Phosphate concentrations increased throughout the early European settlement period, followed by peaks in the late 1930s, c. 1945 and late 1950s. Chlorophyll *a* concentrations increased from the 1980s (to a maximum of 120 $\mu g\ L^{-1}$ total organic matter), which was likely

to be associated with an increase in the frequency of algal blooms. These results indicate that the current ecology of Lake King is very different to that during early European settlement.

At Emerald Lake, sub-Antarctic Macquarie Island (54° 30'S, 158° 57'E) a 50.5 cm long sediment core was collected in order to investigate environmental changes associated with the arrival of humans and the subsequent impacts of introduced feral animals. A reference dataset was constructed consisting of 58 sites of surface sediment diatoms sampled from coastal and inland lakes of differing nutrient status, conductivity and temperature to develop transfer functions. Application of these transfer functions to diatom assemblages in the core enabled the reconstruction of phosphate, conductivity and temperature (based on diatom-phosphate, -conductivity and -temperature transfer functions). The core was dated using ^{210}Pb and ^{14}C with additional analyses carried out on total sedimentary carbon, nitrogen and sulphur content and particle size. Collectively, these analyses revealed a relatively stable environment for 7100 years (average sedimentation rate 0.004 cm yr^{-1}), above which lay 100 years of rapidly deposited sediment (average sedimentation rate 0.34 cm yr^{-1}, maximum sedimentation rate 0.74 cm yr^{-1}), indicating rapid erosion within the lake's drainage basin. This transition corresponded to the arrival of humans on the island in 1810 and introduction of feral animals, in particular rabbits. The biota of the lake changed markedly and became dominated by epiphytic diatom species, while total sedimentary carbon and nitrogen increased and a period of anoxic conditions occurred (inferred from a peak in total sulphur content).

Both of these case studies demonstrate the value of palaeolimnological approaches, based on diatom transfer functions, in providing the temporal perspective needed to define baseline conditions and identify the impacts and consequences of human activities, and provide a clear context for the development and evaluation of future management strategies.

Recent Publications

Fitzsimmons, K.E., Magee, J.W., Amos, K.J. (2009) Characterisation of aeolian sediments from the Strzelecki and Tirari Deserts, Australia: Implications for reconstructing palaeoenvironmental conditions. Sedimentary Geology **218,** 61-73.

Rossi, A.M. and Webb, R.E., 2007. The consequences of allowing unrestricted tourist access at an Aboriginal site in a fragile environment: the erosive effect of trampling. Conservation and Management of Archaeological Sites **9**: 219-36.

Rossi, A.M. and Webb, R.E., 2008. The erosive effect of tourism at an Aboriginal rock art site on the western edge of the arid zone in south-western Australia. Antiquity **82(315)** (http://www.antiquity.ac.uk/ ProjGall/rossi/index.html).

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The annual subscription is AUD35, or AUD25 for students, unemployed or retired persons. To apply for membership, please contact the Treasurer (address below). Members joining after September gain membership for the following year. Existing members will be sent a reminder in December.

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