MONDAY 6TH DEC.

Arrival and registration

10.30-11.00 Morning tea

Arrival and registration

12.30-14.00 Lunch @ The Wilderness Gallery

14.00-14.15 WELCOME

14.15-15.00 **PLENARY 1**: Colhoun, Eric A. The progress of study of glaciation in Tasmania 1973-2004

SESSION 1 DEFINING THE QUATERNARY

15.00-15.15 Naish, Tim*; Pillans, Brad; Beu, Alan; Alloway, Brent. Defining the Quaternary: A New Zealand perspective

15.15-15.30 Carter, Robert M*, ODP Site 1119 - a climatic template for the Southern Ocean for the last 3.9 Ma

15.30-16.00 Afternoon tea

SESSION 2 EMERGING CHRONOLOGIES OF GLACIATION

16.00-16.15 Fink, David*. In-situ cosmogenic radionuclides - is this as good as it can get?

16.15-16.30 White, Duanne*; Gore, Damian; Fink, David; Ferguson, Rob. Constraints on the Charybdis and Lambert Glaciers from cosmogenic isotope dating at Loewe Massif, East Antarctica

16.30-16.45 Hearty, Paul J*. Warm interglaciations, abrupt environmental change, and the Antarctic "Wild Card"

16.45-17.00 Kaufman, Darrell*. Overview of the Pleistocene glacial history of the Ahklun Mountains, SW Alaska

17.00-17.15 Cupper, Matt*; Clark, Dan; Sandiford, Mike; Kiernan, Kevin. Geochronology of periglacial deposits in southwest Tasmania

17.15-17.30 Barrows, T T*; Fifield, L K; Lehman, S. The structure and timing of the last deglaciation in the South Pacific

17.30-17.45 Shulmeister, J*; Rieser, U; Rother, H. Aspects of the nature and timing of glaciation in the middle Rakaia Valley, South Island, New Zealand

17.45-18.00 Rother, Henrik*; Shulmeister, James. Moderate climate cooling as a driver of past glaciations in hyperhumid environments of New Zealand

18.00-19.00 **POSTERS** & Open bar @ the speakers hall

TUESDAY 7TH DEC.

SESSION 3 WATER PASTS – WATER FUTURES: FLUVIAL RECORDS OF ENVIRONMENTAL CHANGE

8.30-8.45 Nanson, Gerald C; Price, David M; Maroulis, Jerry C*; Coleman, Maria; Jones, Brian G; Bowman, Hugo H. Climate and flow regime changes from ~750 ka to the present in the Channel Country of Queensland and South Australia

8.45-9.00 Maroulis, Jerry C; Nanson, Gerald C*; Price, David M. Aeolian-fluvial interaction and source-bordering dune development over the past ~100 ka on Cooper Creek, southwestern Queensland, Australia

9.00-9.15 Kemp, Justine*; Rhodes, Ed; Spooner, Nigel. Late Quaternary fluvial history of the Lachlan Valley, southeastern Australia

9.15-9.30 Pucillo, Kevin*; Nanson, Gerald C; Jones Brian G. Palaeochannel stratigraphy on the Riverine Plain, NSW, Australia: Evidence for higher flood discharges during the late Quaternary

9.30-9.45 Pietsch, Tim*; Nanson, Gerald; Olley, Jon; Price, David. Luminescence chronology for palaeochannels of the lower Gwydir

9.45-10.00 Jansen, John D*; Bishop, Paul; Hoey, Trevor B. Postglacial knickpoints in Bedrock Rivers, Scotland

10.00-10.15 Cohen, Timothy J*; Nanson, Gerald C. Mind the gap: Late Holocene fluvial records for south-eastern Australia — climatic forcing or erosional thresholds?

SPECIAL PRESENTATION

10.15-10.30 Boyles, Warren (Editor of *Tasmania 40°South*). Getting Science into the Media

10.30-11.00 Morning tea

SESSION 4: BIOTIC RESPONES TO CLIMATE CHANGE

11.00-11.15 Hendy, Chris*; Cooke, Penny; Hogg, Alan; Lowell, Tom; Preusser, Frank; Newnham, Rewi; Vandergoes, Marcus. Progress in linking marine and terrestrial records of climate change in the Southern Alps of New Zealand over the past two glacial-interglacial cycles

11.15-11.30 Stevenson, Janelle*; Hope, Geoff S. A comparison of late Quaternary forest changes in New Caledonia and northeastern Australia

11.30-11.45 Kershaw, A Peter*; van der Kaars, Sander; Moss, Patrick T; Wagstaff, Barbara E; Sniderman, Kale. Climate change on orbital scales: how different is Australia?

11.45-12.00 Sniderman, Kale*; Pillans, Brad; O'Sullivan, Paul. Plio-Pleistocene vegetation-fire relationships in upland western Victoria, southeastern Australia

12.00-12.15 Moss, Patrick T*; Kershaw, A Peter. A Quaternary marine palynological record (oxygen isotope stages 1 to 13) for the humid tropics of northeastern Australia based on ODP site 820

12.15-12.30 McKenzie, G Merna*; Kershaw, A Peter. A high resolution pollen record of the last glacial-interglacial cycle from the southeastern highlands of Victoria, Australia

12.30-14.00 Lunch @ The Wilderness Gallery

14.00-14.45 PLENARY 2: Cosgrove, Richard. Human responses to large and small-scale temporal and spatial climatic shifts during the last ice age

SESSION 5 WINDOWS INTO PAST CLIMATE VARIABILITY: SPELEOTHEMS & CORALS

14.45-15.00 Woodhead, Jon*; Hellstrom, John; Maas, Roland. U-Pb dating of speleothems: progress towards a robust methodology?

15.00-15.15 Waring, Chris*; Griffith, David; Wilson, Stephen; Parkes, Stephen; James, Julia; Stone, David. The problem with speleothems

15.15-15.30 McDonald, Janece*; Drysdale, Russell; Chisari, Robert; Hill, David; Wong, Henri. The 2002-2003 El Niño recorded in Australian cave drip waters: implications for reconstructing rainfall histories using stalagmites

15.30-16.00 Afternoon tea

16.00-16.15 Desmarchelier, Jol*; Hellstrom, John; Spate, Andy. Constraining relative wildfire frequency in the Australian alps over the past 500,000 years, using U-Th dating of speleothem-encapsulated soot layers

16.15-16.30 Hellstrom, John*. Constraining the timing of past glacial-interglacial transitions using stacked speleothem growth rate records from Nettlebed Cave, NZ

16.30-16.45 Drysdale, Russell*; Zanchetta, Giovanni; Hellstrom, John; Zhao Jian-xin; Fallick, Anthony. The timing and nature of Termination 2 in the central Mediterranean basin inferred from an Italian stalagmite

16.45-17.00 Williams, Paul W*; King, Darren N; Zhao, Jian-xin; Collerson, Kenneth D. Composite d18O and d13C speleothem records from 25 ka until present from South Island, New Zealand – was there really a global YD?

17.00-17.15 Westaway, K E*; Gagan, M K; Zhao, J-x; Chivas, A R; Roberts, R G. Reconstructing palaeoclimates and environments during human occupation, either side of Wallace's Line, Indonesia: Preliminary results from speleothems

17.15-17.30 Zhao, Jian-Xin; Wang, Yong-jin; Feng, Yue-Xing*; Xia, Qikai; Gagan, Michael K; Collerson, Kenneth D. Speleothem records for the last Glacial - Holocene transition - case studies from China and Australia

17.30-17.45 McGregor, Helen V*; Gagan, Michael K. Mid-Holocene abrupt climate shift and changes in El Niño revealed by tropical western Pacific corals

17.45-18.00 Maas, Roland*; Ihlenfeld, Chris; Webb, John A: Drysdale, Russell. High-resolution climate records in freshwater tufa

18.00-19.00 **POSTERS** & Open bar @ The Speakers Hall

WEDNESDAY 8TH DEC.

SESSION 6 WATER PASTS – WATER FUTURES: LACUSTRINE TO LOESS

8.30-8.45 English, Pauline*. The environmental context and origin of salinity in Australia

8.45-9.00 Saunders, Krystyna M*; McMinn, Andrew; Roberts, Donna; Hodgson, Dominic A; Heijnis, Henk. Recent human-induced salinity changes in Orielton Lagoon, southeast Tasmania

9.00-9.15 Alloway, Brent*. An integrated LGM to post-glacial paleoenvironmental record from Taranaki, western North Island, New Zealand

9.15-9.30 Augustinus, Paul*; Hagg, Joe; Shane, Phil; Deng, Yanbin. LGM to early Holocene environmental changes recorded in Onepoto Maar Crater, Auckland, New Zealand

9.30-9.45 Petherick, Lynda*; McGowan, Hamish; Kamber, Balz. A 25 000 year record of climatic variability for southeast Queensland reconstructed from water content and aeolian dust deposition in "dry" lake sediments

9.45-10.00 Marx, Samuel K*; Kamber, Balz S; McGowan, Hamish A. Determination of the provenance of long-travelled dust in geologic archives: A study using the ultra trace element chemistries of eastern Australian dusts

10.00-10.15 Campbell, James R*; Hesse, Paul P; Olley, Jon M. Single grain OSL dating of an Australian loess-like profile

10.15-10.30 Rhodes, Ed*; Magee, John; Fitzsimmons, Kat; Chappell, John. Discrete periods of aeolian activity during the last glacial cycle in Australia

10.30-11.00 Morning tea

SESSION 7: BIOTIC RESPONES TO CLIMATE CHANGE

11.00-11.15 McLeod, Alex*. Spatial and temporal vegetation variation and soil processes interpreted from soil charcoal, Central Highlands, Victoria

11.15-11.30 White, D Christopher*. Climate change and environmental response in southeastern Australia: A palaeoecological record from Lake Surprise, Western Plains of Victoria

11.30-11.45 Johnston, Rochelle*; Kershaw, A Peter; Turney, Chris; Bryant, Charlotte; Tibby, John; Jacobsen, G. A high resolution, multiproxy record of the Last Glacial Maximum to Holocene transition from the volcanic lake sediments of Tower Hill, southeastern Australia

11.45-12.00 Turney, Chris S M*; McGlone, Matt S; Wilmshurst, Janet M. Millennial-scale climate cycles through the Holocene: A global, synchronous phenomena?

12.00-12.15 Jordan, Greg*. Conflicts in physical and biological palaeoclimatic evidence, a bit of Tasmaniana

12.15-12.30 Worth, James*; Vaillancourt, René; Jordan, Greg. Where did *Nothofagus cunninghamii* survive the ice ages?

12.30-14.00 Lunch @ The Wilderness Gallery

14.00-14.45 **PLENARY 3**: Howard, William R. Approaches to land-sea-ice correlation of palaeoclimate records

SESSION 8 MARINE ARCHIVES

14.45-15.00 Stuut, Jan-Berend W*; Hebbeln, Dierk. Climate variability at the southern boundaries of the Namib (southwestern Africa) and Atacama (northern Chile) coastal deserts during the late Quaternary

15.00-15.15 Hesse, Paul*. Long Quaternary records of wind strength from northern and southern Australia

15.15-15.30 Zhao, Jian-Xin*; Yu, Ke-Fu; Wei, Gang-jian. Sea-level, sea surface temperature and salinity change in the South China Sea since mid-Holocene

15.30-16.00 Afternoon tea

INTIMATE WORKSHOP

16.00-16.15 Alloway, Brent*; Shulmeister, James; Newnham, Rewi; NZ-INTIMATE Members. Outcomes of the 2004 NZ-INTIMATE Meeting, GNS-Rafter Laboratory, Wellington, New Zealand

16.15-16.30 Haberle, Simon*; and OZ-INTIMATE Members. Outcomes of the 2004 OZ-INTIMATE Meeting, ANSTO, Lucas Heights, NSW, Australia

16.30-18.00 Discussion

18.00 19.00 AQUA AGM

THURSDAY 9TH DEC.

SESSION 9 WATER PASTS – WATER FUTURES: SOILS & SWAMPS

8.30-8.45 Tomkins, Kerrie M*; Humphreys, Geoff S. Geomorphology of upland swamps in southeastern Australia and implications for interpreting environmental change

8.45-9.00 Shanhun, Fiona L*; Almond, Peter C; Shulmeister, James; Rieser, Uwe. A late MIS 3 to present paleoprecipitation record from Birdlings Flat formation loess, Banks Peninsula, Canterbury, New Zealand: (1) Soil stratigraphy and chemistry

9.00-9.15 Almond, Peter C*; Shanhun, Fiona L; Faure, Kevin; Shulmeister, James; Rieser, Uwe. A late MIS 3 to present paleoprecipitation record from Birdlings Flat formation loess, Banks Peninsula, Canterbury, New Zealand: (2) Stable isotope composition of pedogenic carbonate

9.15-9.30 Hammond, Andrew P*; Palmer, Alan S. Soilscapes and Late Quaternary landscape evolution of western Hawkes Bay, New Zealand using tephras as a time control

9.30-9.45 Hughes, Matthew W*; Almond, Peter C; Roering, Joshua J. Quaternary environmental changes influence soil transport rates on a dissected loess mantled terrace

SESSION 10: BIOTIC RESPONES TO CLIMATE CHANGE

9.45-10.00 Kenyon, Christine E*. Long distance aerial dispersal of pollen from Brassicaceae crops

10.00-10.15 Thomas, Ian*. Modern pollen in northeastern Tasmania

10.15-10.30 Elwood, Cecilia*. A discontinuous late-glacial and Holocene vegetation record from Pine Lake, Central Plateau, Tasmania

10.30-11.00 Morning tea

11.00-11.15 Fletcher, Michael*. Boco Valley: A glimpse of pre-Aboriginal western Tasmania

11.15-11.30 Shimeld, Peter*. The last interglacial at Port Stephens, New South Wales

11.30-11.45 Porch, Nick*; Sniderman, Kale; Jordan, Greg. A warm, wet early Pleistocene in southeastern Australia: The beetle and plant record from the western uplands of Victoria

11.45-12.00 Burge, Philip I*. A stage 5, paleoenvironmental and paleoclimatic reconstruction from the West Coast, South Island, NZ, using beetle fossils

12.00-12.15 Woodward, Craig*. Cracking the chironomid code: Developing New Zealand chironomids as a proxy for past environmental change

12.15-12.30 Gibson, John AE*; Swadling, Kerrie M; Cromer, Louise; Bayly, Ian A E; Bissett, Andrew. The origins of freshwater fauna of Antarctic lakes

12.30-12.45 Cromer, Louise*; Gibson, John A E; Swadling, Kerrie M; Hodgson, Dominic A. Evidence for a faunal refuge in the Larsemann Hills, East Antarctica, at the Last Glacial Maximum

12.45-14.00 Lunch @ The Wilderness Gallery

14.00-14.45 Pearson, Stuart*; Harvey, Sarah; Greentree, Erin; McCullough, Dale. How can information about environmental history be more useful? Tree rings and rat nests - what do they tell us about Yathong and about Quaternary science pathways?

14.45-15.00 Haberle, Simon*; Tibby, John; Dimitriadis, Sophia; Heijnis, Henk. The impact of European occupation on terrestrial and aquatic ecosystems dynamics in an Australian tropical rainforest

15.00-15.15 Sim, Anna*; Heijnis, Henk; Mooney, Scott. Use of the pollen record to investigate vegetation thickening in central Queensland over the last 120 years

15.15-15.30 Yu, Ke-Fu*, Zhao, Jian-Xin. High-precision TIMS U-series and AMS ^{14}C dating of a coral reef lagoon sediment core from southern South China Sea and its environmental significance

15.30-16.00 Afternoon tea

16.00-18.00 Information session: PAGES-PalComm, INQUA 2007

19.00 AQUA DINNER

FRIDAY 10TH DEC.

Excursions

Full Day	**Botanical Walk (Greg Jordan and James Worth)**
Mole Creek Caves	**Bus and private car**

POSTERS

1. Alloway, Brent*; Barrell, J A David; Barker, Dan, The potential for retrieving a high-resolution southern mid-latitude record of LGM to post-glacial climate change from beneath Lake Pukaki, South Island, New Zealand
2. Davies, Sarah E*; Turney, Chris S.M; Kershaw, A Peter, A tephrochronological framework for Northern Australia: Testing the timing of fires, El-Nino and human occupancy
3. Drysdale, Russell*; Zanchetta, Giovanni; Hellstrom, John, Maas, Roland; Cartwright, Ian; Fallick, Anthony; Piccini, Leonardo; Pickett, Matthew, A multi-proxy record of hydrological variations during the Holocene from an Italian cave deposit
4. Feng, Yue-Xing*; Zhao, Jian-Xin; Gagan, Michael K, Speleothem record of periodic climatic variations in Tasmania during 128-100 ka before present (BP)
5. Gouramanis, Chris*, High resolution Holocene climate from southern Western Australia using ostracods
6. Haberle, Simon*, Robinson Crusoe's legacy: An environmental history of the Juan Fernández Archipélago, Chile
7. Hendy, Chris*, Coring stiff sediments in a glacial terrain
8. Hesse, Paul*; Olley, Jon, High latitude and low latitude air mass movements over southeastern Australia over the last full glacial cycle
9. Ladd, Philip *; Clarke, Ian, A 1500 year pollen record from Mt Strzelecki, Flinders Island
10. Paterson, Kristina*; White, Camille A; Gibson, John A E; Swadling, Kerrie M, A tale of two cores: Unravelling the history of Abraxas Lake, Antarctica
11. Pillans, Brad; Alloway, Brent*; Naish, Tim; Abbott, Steve; Palmer, Alan; Westgate, John, The distal archive of North Island silicic volcanism recorded in Pleistocene shallow marine sediments of Wanganui Basin, New Zealand
12. Yu, Ke-Fu*; Zhao, Jian-Xin, Mid-Holocene century-scale sea level fluctuations recorded in microatolls at Leizhou Peninsula, northern South China Sea

PLENARY PRESENTATIONS

Colhoun, Eric A

School of Environmental and Life Sciences, University of Newcastle, NSW

The progress of study of glaciation in Tasmania 1973-2004

Views on the glaciation of Tasmania in 1973 either subscribed to the undated threefold glaciation model of the Hobart Lawyer Arndell Lewis or to the view that the lack of dating did not justify the mode, and that virtually all glaciation of Tasmania belonged to the last glaciation. From 1973 researchers in a School of Glacial Geomorphology based initially on the University of Tasmania studied the extent, age and complexity of glaciation in Tasmania using field, relative and absolute dating methods to create a new model. The talk will outline the progress of that research highlighting the key advances in understanding.

Cosgrove, Richard

Archaeology Program, La Trobe University

Human responses to large and small-scale temporal and spatial climatic shifts during the last ice age

Archaeological evidence of Tasmania's Ice Age Aboriginal occupation has been a major research focus of the Archaeology Program at La Trobe University. The evidence is obtained from numerous cave and rockshelter sites in southwest Tasmania, with radiocarbon ages derived from charcoal accompanying human artefacts – animal bones and stone tools – dug from various depths.

The earliest dates from these caves are at least 35,000 old and show that people used the Bassian land bridge to walk to Tasmania when sea levels were lower. Remarkably, at the end of the Ice Age the numerous long-occupied sites in the mountainous south-west were abandoned. The people's reliance Bennett's wallabies explain this, as this was their principal source of food and warm clothing. The animals depended on areas of grasses and herbs that grew at the higher altitudes during the Ice Age; but with the subsequent warmer and moister climate, the temperate forests at lower altitudes expanded upwards to engulf the grassed areas, and the animals dispersed to other locations.

In eastern Tasmania, the situation was very different. Evidence from rock shelters shows human occupation there by at least 30,000 years ago but at much lower densities. It appears that during the Ice Age, the climate of the east was highly variable, with significant periods of aridity due to the general dryness of the atmosphere. In the west, moisture was more reliable and humans hunted wallabies and wombats in great numbers, their bones accumulating in the cave sites.

At what time of the year people exploited these resources had, until recently, remained a mystery. It was assumed that it had occurred during summer. Our recent work using the skeletochronological analysis of Bennett's wallaby (*Macropus rufogriseus*) from Tasmania's earliest sites has shown great potential of unlocking human seasonal land use patterns during the LGM. In particular, wallaby teeth have given us an amazing insight into seasonal use of the cave sites. Incredibly these Aboriginal hunters occupied these upland valleys during the coldest months, principally between autumn and early spring. It is not known where they spent much of the summer; it may have been on the coast or areas to the north. Research on these aspects continues to fascinate us, demonstrating the resourcefulness and flexibility of Australia's earliest settlers.

Howard, William R

Antarctic Climate & Ecosystems Cooperative Research Centre

Approaches to land-sea-ice correlation of palaeoclimate records

Efforts to put palaeoclimate records from deep-sea sediments, lake and bog sediments, and ice cores on a common timescale depend on chronostratigraphic variables which can be assumed or demonstrated to be synchronous in all three environments. These have included: pollen variations and radiocarbon in terrestrial and marine sediments, oxygen isotopes and dust in ice and marine cores, and palaeotemperature estimates in all three types of records. All these types of correlation approaches require assumptions; e.g. that atmosphere-ocean radiocarbon reservoir differences are constant or known; or that temperature variations are synchronous among regions. Such assumptions are sometimes violated, e.g. the demonstrated changes in atmosphere-ocean ^{14}C age difference during the glacial maximum and deglaciation.

An added approach is the use of ocean and ice-core pCO_2 histories, though it requires the assumption of complete equilibration between ocean and atmosphere. This carbon-cycle approach may also be applicable to multiple ocean regions, allowing a fuller accounting for regional contributions to ocean-atmosphere carbon exchange.

I attempt to produce a single chronology for ice-core, pollen, and deep-sea core records from the Southern Hemisphere. A core from the subantarctic south of Tasmania provides a good test case for this approach, as it preserves a record of the last 27000 years at a sedimentation rate of about 4 cm/kyr, with chronology controlled by 11 AMS dates. Palaeotemperature variations and benthic and planktonic stable isotope records, as well as carbon-cycle-constraints suggest a pCO_2 history for the region that has the timing and amplitude to match the atmospheric CO_2 change.

SPOKEN PRESENTATIONS

Alloway, Brent*

Institute of Geological & Nuclear Sciences, Wairakei Research Centre, Private Bag 2000, Taupo, NZ

An integrated LGM to post-glacial paleoenvironmental record from Taranaki, western North Island, New Zealand

Taranaki, situated in western North Island, New Zealand, has a number of important regional attributes that promote the preservation of multi-proxy LGM to post-glacial paleoenvironmental records. Firstly, its exposed western coastal position with an adjacent broad continental shelf is ideally located for registering subtle fluctuations in windiness, precipitation and temperature. Secondly, the region has been dominated by an intermittent but continuously active Egmont Volcano that has provided a steady supply of volcaniclastic deposits over a c. 127 ka interval. This eruptive centre has facilitated the preservation of lake and peat sediments as well as provided the primary source of andic deposits whose properties are significantly influenced by climatic fluctuations. In addition, Egmont-sourced tephra beds have proven themselves as useful chronostratigraphic markers enabling regional and inter-regional correlation. Coalesced fans of laharic, pyroclastic and alluvial deposits extending from Egmont Volcano have facilitated the formation of peat deposits either in enclosed depressions developed at the fan margins or upon initial depositional surfaces. Elsewhere on depositional surfaces, allophanic-dominated soils (Andisols) have accumulated from episodic accretion, and subsequent weathering of aerially transported fine-grain sediment of dominantly andesitic provenance. The strongly contrasting morphological characteristics of reddish (Sr-) and loess-like yellowish (Sy-) beds indicate that the intensity of surficial weathering has not remained constant and that variations reflect climatic oscillations. Aerosolic quartz flux within andic beds has also been determined and indicates a pronounced peak coinciding with the accretion of Sy1 during $\delta^{18}O$ Stage 2. Quartz flux determined at two sites (Waitui & Onaero) is near-synchronous but is not constant. Variations in quartz flux appear to reflect fluctuations in wind strength during the LGM.

Alloway, Brent* (1); Shulmeister, James (2); Newnham, Rewi (3); NZ-INTIMATE Members

(1) Institute of Geological & Nuclear Sciences, Wairakei Research Centre, Private Bag 2000, Taupo, NZ; (2) Department of Geological Sciences, University of Canterbury, Te Whare Wananga o Waitaha, Private Bag 4800, Christchurch, NZ; (3) School of Geography, University of Plymouth, Plymouth PI4 8AA, UK

Outcomes of the 2004 NZ-INTIMATE Meeting, GNS-Rafter Laboratory, Wellington, New Zealand

The purpose of this inaugural NZ-INTIMATE meeting was to: (a) identify and prioritise NZ onshore and offshore references records for MIS 2 and 2/1 transition with the ultimate goal of developing and event stratigraphy for the region; (b) promote ways to improve procedures for establishing the precise ages of, and effecting high resolution correlations between, these key onshore and offshore NZ records.

At the meeting there was unanimous agreement between the c. 45 attendee's that two posters be produced by the NZ-INTIMATE community intended for both NZ and Australasian usage. Poster 1 will present continuous proxy records spanning 30 ka to late Holocene (pre-Polynesian arrival) or time zero (now) and will be essentially chronostratigraphic in presentation. The following records were selected for inclusion: Auckland maar, Okarito, Otamangakau, Kaipo, NZ speleothem, and marine (MD97-2121, -2122). In addition, fragmentary records (e.g. Quartz flux to andic soils, loess, aggradation and glacial) are to be included on the poster along with two inset maps (LGM and Late Holocene) showing the location of proxy record sites, shorelines, glacial extents and vegetation. Poster 1 is currently under production. It was agreed that Poster 2 would be essentially interpretative and follow on from Poster 1. Poster 2 is intended to present a provisional NZ event stratigraphy as well as

identify intervals of warming/cooling, ocean productivity etc. Poster 2 will contain Antarctic and Northern Hemisphere (GISP, GRIP) records for comparative purposes.

The next stage is to reconcile the New Zealand record with that of the equivalent-aged Australian record in order to formulate an overall Australasian reference record.

Almond, Peter C*; Shanhun, Fiona L (1); Faure, Kevin (2); Shulmeister, James (3); Rieser, Uwe (4)

(1) Soil and Physical Sciences Group, Division of Agriculture and Life Sciences, Lincoln University, Canterbury, New Zealand; (2) Geological and Nuclear Sciences, Gracefield, Lower Hutt, New Zealand; (3) Department of Geological Sciences, University of Canterbury, New Zealand; (4) School of Earth Sciences, Victoria University of Wellington, New Zealand.

A late MIS 3 to present paleoprecipitation record from Birdlings Flat formation loess, Banks Peninsula, Canterbury, New Zealand: (2) Stable isotope composition of pedogenic carbonate

Quantitative paleoprecipitation records from the east coast of the South Island are needed to test hypotheses of drivers of glaciation and deglaciation in the Southern Hemisphere, yet few proxies exist. Stable isotope geochemistry of pedogenic carbonate in loess of Birdlings Flat formation on the western flanks of Banks Peninsula provides such a record. Pedogenic carbonate forms in equilibrium with soil CO_2. In the absence of C3/C4 plant fractionation effects, the isotopic composition of soil CO_2 is determined by the extent of mixing of isotopically heavy atmospheric CO_2 and isotopically light CO_2 derived from soil respiration. Under low respiration conditions heavier atmospheric CO_2 diffuses into the soil. Soil respiration has been shown to be most strongly influenced by soil moisture regime, which is directly related to precipitation. $\delta^{13}C$ and $\delta^{18}O$ were measured in pedogenic carbonate between 2.5 m to 13 m depth in Birdlings Flat loess at Ahuriri quarry. From radiocarbon dating the carbonate ranges in age from ca. 30 000 yr B.P. to 9 000 yr B.P. $\delta^{13}C$ data are interpreted to show two shifts from precipitation under dry to wetter conditions. The first wet phase occurred immediately after 30 000 yr B.P. The dry phase that replaced it ended at 19 000 yr B.P. The last phase of relative wetness extended into the Holocene until after 9 000 yr B.P. when rainfall was high enough to prevent carbonate precipitating. Carbonate Delta13 C will be calibrated to mean annual rainfall using modern analogues under which carbonate is presently precipitating.

Augustinus, Paul* (1); Hagg, Joe (2); Shane, Phil (3); Deng, Yanbin (4)

(1) School of Geography and Environmental Science, and Department of Geology, University of Auckland, Auckland, New Zealand; (2) School of Geosciences, University of Edinburgh, Edinburgh, UK; (3) Department of Geology, University of Auckland: (4) School of Geography and Environmental Science, University of Auckland.

LGM to early Holocene environmental changes recorded in Onepoto Maar Crater, Auckland, New Zealand

Onepoto maar crater contains an almost continuous and high-resolution record of lacustrine sedimentation spanning up to 250 kyr. Presented here is a section of interest that covers the period from ca. 28 to 8 ^{14}C kyr BP during which ~ 4 m of laminated organic-rich sediments accumulated in a deep paleolake. Tephra from the central North Island are present throughout the sequence, and provide a chronostratigraphic framework underpinned by AMS ^{14}C ages. Environmental changes within the lake and catchment are interpreted from variations in a range of physical, chemical, and biological proxy indicators including: grain size, major oxide and trace element geochemistry, total organic matter content, elemental carbon/nitrogen ratios, carbon and nitrogen isotopes, magnetic susceptibility, pollen, diatom assemblages and biogenic silica content. These proxies have allowed us to infer changes in the extent and productivity of vegetation in the lake and catchment, as well as changes in the source of sediments. Elements of the bulk organic matter and geochemical content of the sediments preserved a high-resolution record of vegetation response to climate perturbations,

even during climatic events that were probably insufficient to induce major changes in the vegetation assemblages. The details of the paleoenvironmental records will be discussed as will their implications for late glacial paleoclimate in the SW Pacific.

Barrows, T T* (1); Fifield, L K (1); Lehman, S (2)

(1) Department of Nuclear Physics, Research School of Physical Sciences and Engineering, The Australian National University, ACT, 0200, Canberra, Australia (2) Institute of Arctic and Alpine Research, University of Colorado, Boulder, USA.

The structure and timing of the last deglaciation in the South Pacific

The last Termination in the North Atlantic Ocean was characterized by an abrupt return to near glacial conditions during the Younger Dryas event (YD). The effects of the YD are strong on the Greenland ice sheet, as recorded in ice cores, and within Europe, where glaciers advanced for several hundred years. However, its effects become less discernable with distance from the North Atlantic Ocean, suggesting a link with thermohaline circulation and North Atlantic Deep Water formation. No clear YD is recorded in the Antarctic ice cores, although a brief cooling is recorded shortly before it (The Antarctic Cold Reversal). Elsewhere in the Southern Hemisphere there is only circumstantial evidence. The strongest of this evidence is in New Zealand where moraines have been dated close to the YD Chronozone. In this talk we will present new records from New Zealand and the adjacent Tasman Sea to investigate the possible presence of the YD in this region. First, we exposure dated the Waiho Loop moraine putatively deposited by the Franz Josef glacier during the YD. Preliminary exposure ages indicate that the moraine was deposited before this event. Second, we constructed a high-resolution sea-surface temperature record in a deep-sea core off the coast of the South Island. The Last Glacial Maximum is brief with characteristics similar to the glacial record in Australia (Barrows et al., 2001, 2002). Postglacial warming takes places in two main steps, with no North Atlantic style cooling during the YD Chronozone. We find little support for the assertion that the YD is a global phenomenon.

Burge, Philip I*

Department of Geological Sciences, University of Canterbury

A stage 5, paleoenvironmental and paleoclimatic reconstruction from the West Coast, South Island, NZ, using beetle fossils

The West Coast of New Zealand is an important area for research into the climatic history of New Zealand because the flights of uplifted marine terraces both preserve a long history of climatic and environmental change and have been used to correlate between the Late Quaternary terrestrial (glacial) and marine records in New Zealand. Despite their importance there are surprisingly few published paleoenvironmental works. Furthermore, no attempts have been made to acquire quantitative paleoclimatic estimates from these deposits.

Beetle fossils have long been used for the reconstruction of paleoclimate and paleoenviroments in the Northern Hemisphere and recent work by Marra (eg. Marra, 2003), has demonstrated that this method is very applicable in New Zealand. This paper presents a quantitative climatic and environmental reconstruction, using beetle fossils recovered from an organic silt layer situated within an Oxygen Isotope Stage (OIS) 5 terrace, located 4km east of Westport on the West Coast of the South Island, New Zealand. The site dates to beyond the range of radiocarbon dating. Luminescence samples have been submitted but it is highly likely that the site is OIS 5 in age.

In all 16 beetle species and 15 "species groups" or genera have been keyed out. In addition 5 taxa have been identified to tribe (all Cryptorynchini weevils) and 3 taxa to family level. The initial examination of the fossil assemblage indicates a forest fauna. Final environmental interpretations are under way and a complete paleoenvironmental reconstruction and paleoclimatic estimate for the site will be presented.

References:
Marra, M. J. (2003). "Last interglacial beetle fauna from New Zealand." Quaternary Research 59: 122-131.

Campbell, James R* (1); Hesse, Paul P (1); Olley, Jon M (2)

(1) Department of Physical Geography, Macquarie University, Sydney, NSW 2109; (2) CSIRO Land and Water, Canberra, ACT 2601

Single grain OSL dating of an Australian loess-like profile

Loess-like soil mantles in the Central Highlands of NSW have been established by a number of recent studies. Large aliquot optical dates of two of these profiles, Mackenzie's waterholes creek cutting (MWC) and Browns Creek, near Carcoar and Blayney, indicated near linear rates of dust deposition through the late Quaternary. It was considered that this result was possibly an artefact caused by local reworking of dust after deposition. In order to investigate this more thoroughly, single grain dating was carried out on the deeper MWC profile.

Single grain results show large grain to grain variations in palaeodose at the six sample depths (40, 60, 80, 120, 160 and 280cm). This variation can be interpreted as resulting from a high degree of mixing within the profile. This high likelihood of interlayer mixing places serious constraints on the ability to determine depositional ages throughout the profile. The spread of single grain palaeodoses confounds attempts to select an appropriate burial age, as age identification on the basis of either lowest dose or highest dose populations are invalidated by the interlayer mixing.

These results have clear implications for the precision and accuracy of large aliquot dating in this type of profile. Large aliquot results show a high degree of precision due to averaging and, on the basis of single grain results, a low degree of accuracy. Modelling of interlayer mixing and depositional history may offer some insights into the development of this profile. However it remains to be seen whether this approach will allow a deposition age profile to be determined.

Carter, Robert M*

James Cook University, Townsville

ODP Site 1119 - a climatic template for the Southern Ocean for the last 3.9 Ma

Accepted records of "global" climatic history are generally at best regional-hemispheric in their stretch, and the North Atlantic and Southern Ocean-Antarctic regions have different, albeit related, climatic histories. By happenstance, the Vostok (to 0.4 Ma) and EPICA (to 0.72 Ma) ice cores provide a longer continuous climatic time series for the Antarctic region than Greenland cores (NGRIP to 0.123 Ma) do for the boreal region. The southern polar climatic history is matched closely back to the current base of the EPICA record by the mid-latitude record of ODP Site 1119. In addition, Site 1119 offers an apparently continuous climatic record back to 3.9 Ma. Site 1119 therefore provides a valuable reference site, both because the climatic history that it manifests extends over at least 45^0 of latitude, and because its location in intermediate depth waters yields climate proxies which bridge the deep ocean, onland and atmospheric records.

ODP Site 1119, at a water depth of 395 m within the Antarctic Intermediate Water (AAIW) Canterbury Drifts, is located just east of South Island, New Zealand. A mid-latitude mountain icecap has been present over the actively uplifting Southern Alps (3764 m high) during periods of recent glaciation. Site 1119, lying ~80 km offshore today but within ~15 km of recent glacial lowstand shorelines, is in an ideal location to intercept sedimentary products from the waxing and waning of this icecap. Natural gamma-ray measurements from Site 1119 provide a record of South Island clay discharges which closely matches the Antarctic Vostok deuterium (air-temperature) record, at millenial scale and back to marine isotope stage 9 at ~340 ka. The 1119C downhole gamma record extends to the ~3.9 Ma base of the 495 mbsf deep hole, and comprises the best available proxy record for Southern Ocean-Antarctic air temperature back to the middle Pliocene.

Cohen, Timothy J*; Nanson, Gerald C

School of Earth and Environmental Sciences, University of Wollongong, NSW, 2522.

Mind the gap: Late Holocene fluvial records for south-eastern Australia — climatic forcing or erosional thresholds?

Existing basal radiocarbon chronologies for floodplains and upland swamps in south-eastern Australia have been compiled for the area 30º S – 42º S and for altitudes ranging from 20 – 1000 m.a.s.l (*i.e*. beyond the influence of post-LGM sea-level processes). The fluvial record (comprising 50 basal radiocarbon dates where basin area is > 50 km^2) indicates a distinct 'gap' in the sedimentary record between 8.5 and 4.5 ka BP. Basal radiocarbon ages range from 4 through to 0.5 ka BP, with 3.5 ka BP representing the greatest frequency of basal ages. The early-mid Holocene gap in the sedimentary record is discussed in relation to sampling and dating techniques and possible palaeoenvironmental implications. Lake-level curves for Lake George (35º S) and for Lake Keilambete (38º S) suggest higher than present lake-levels during the gap. It is suggested that many of the floodplain sites record a shift in climatic conditions from a period of more-pronounced lateral activity in the early-mid Holocene to a period dominated by vertical accretion processes from 4 ka BP onwards.

The record for upland swamps (with basin areas < 50 km^2), however, shows a more uniform distribution of basal ages throughout the Holocene. As previously suggested, these landscape features record a history of cutting and filling driven by intrinsic controls rather than extrinsic climatic factors. This paper provides an initial examination of the morphological controls on sediment preservation and discusses recent luminescence work that reinforces the existing radiocarbon chronology.

Cromer, Louise* (1); Gibson, John A E (2); Swadling, Kerrie M (1); Hodgson, Dominic A (3)

(1) Department of Zoology, University of Tasmania, TAS 7018; (2) Institute for Antarctic and Southern Ocean Studies, University of Tasmania, TAS 7018; (3) British Antarctic Survey, Natural Environment Research Council, High Cross, Cambridge, UK. CB3 OET

Evidence for a faunal refuge in the Larsemann Hills, East Antarctica, at the Last Glacial Maximum

Little is known about the origins and palaeobiogeography of the Antarctic freshwater fauna. Theories based on vicariance (species survived the Last Glacial Maximum in refugia) and dispersal (all fauna are Holocene colonisers) have been suggested, but with little if any supporting evidence. Here we present research into the palaeoecology of Lake Reid, Larsemann Hills, East Antarctica (76º23'E; 69º23'S), with particular reference to the metazoan fauna. Lake Reid is unusual in that, unlike most Antarctic lakes, the sediment record extends back to at least 40 000 ^{14}C yr BP. This implies that the area surrounding the lake was ice-free at the Last Glacial Maximum when the nearly all Antarctic lake basins were overridden by ice. By analysing zooplankton remains preserved in the core the population dynamics of many taxa could be determined. Ephippia and mandibles from the cladoceran *Daphniopsis studeri* and loricae of the rotifer *Notholca sp.* were found at every depth in the core, implying that these species were present prior to the LGM and are not Holocene colonisers. Copepod mandibles, most likely belonging to *Acanthocyclops mirnyi*, were also identified in the older section of the core, yet were not present in the most recent sediments, indicating local extinction of this species. Remains of tardigrades as well as several other as-yet-unidentified egg types were also present with varying distributions throughout the core. These distributions and their implications for Lake Reid's palaeoecology will be discussed in conjunction with a multi-proxy data set that includes geochronology, diatoms, pigments and carbonate stable isotopes.

Cupper, Matt* (1); Clark, Dan (2); Sandiford, Mike (1); Kiernan, Kevin (3)

(1) School of Earth Sciences, The University of Melbourne, Victoria 3010; (2) Geoscience Australia, GPO Box 378, Canberra, ACT 2601; (3) School of Geography and Environmental Studies, University of Tasmania, Hobart, Tasmania 7001

Geochronology of periglacial deposits in southwest Tasmania

Alluvial fans along the base of the Mt Anne massif provide evidence for periglacial activity in southwest Tasmania during the Late Pleistocene. The ~30 km long Lake Edgar fault scarp bisects several of these fans, with displacement during active, episodic alluvial deposition forming at least three terraces. Optically stimulated luminescence (OSL) dating suggests that the last major phase of fan aggradation occurred between ~34-21 ka (weighted mean age: 27.8 ± 1.4 ka). We infer that fan construction requires the removal of stabilizing vegetation, as little appreciable accumulation of clastic sediments is occurring in the present landscape. The climate during the last major phase of fan aggradation, which immediately precedes the global last glacial maximum (LGM), is likely to have been substantially colder than present. This would have contributed to the inferred contraction of plant communities. Runoff was probably also higher, enhancing sediment transport. Older gravel sequences yielding ages of 61 ± 7 ka and 48 ± 8 ka may relate to previous episodes of landscape instability during the early—middle last glacial. Colluvial deposits along the 2-8 m high scarp face date to ~19-17 ka, constraining the last phase of fault movement to the LGM. Their accumulation reflects continued instability during the late glacial. Basal sediments in a sag pond within the footwall of the fault show organic sedimentation resumed near the termination of the last glacial at around 12-10 ka. Landscapes have been largely stable since this time.

Desmarchelier, Jol* (1); Hellstrom, John (2); Spate, Andy (3)

(1) Research School Earth Sciences, The Australian National University, Canberra, ACT 0200; (2) School of Earth Sciences, The University of Melbourne, VIC 3010; (3) Optimal Karst Management, 2/10 Victoria Street, Hall, ACT, 2618

Constraining relative wildfire frequency in the Australian alps over the past 500,000 years, using U-Th dating of speleothem-encapsulated soot layers

Jersey cave at Yarrangobilly in the Australian alps is an unusual example of a cave that traps smoke during nearby bushfire events, which then settles onto horizontal surfaces within as soot. Rich, massive speleothem growth within the cave over the last half-million years or more ensures that a great number of such soot layers have been incorporated into speleothem calcite and thus might be directly dated using U-Th disequilibrium dating.

Here we report progress in deriving a chronology for relative bushfire frequency above or near the cave covering the last several hundred thousand years. Seven speleothem core samples have been recovered from the cave and dated using more than 30 U-series age determinations. Dating is complicated by high detrital thorium content and slow growth rates and has required the use of a MC-ICP-MS technique able to produce ages from extremely small samples. Age models and their corresponding uncertainty envelopes are derived from the U-Th age determinations using a Monte-Carlo randomisation technique, which fully accounts for all sources of uncertainty and allows the derivation of a relative age probability histogram for each observed soot layer. Stacked age histograms for each core reveal that bushfires have been a feature of the region for more than 500,000 years, and have increased in frequency over the last 300,000 years. Fires have most commonly occurred during interglacials and interstadials, and appear to have been more frequent during the last interstadial (MIS 3) and the Holocene than in previous warm periods.

Drysdale, Russell* (1); Zanchetta, Giovanni (2); Hellstrom, John (3); Zhao Jian-xin (4); Fallick, Anthony (5)

(1) Environmental Geoscience Group, The University of Newcastle, Callaghan 2308, Australia; (2) Scienze della Terra, Università degli studi di Pisa, Pisa 56100, Italy; (3) School of Earth Sciences, The University of Melbourne, Parkville 3052, Australia; (4) Department of Earth Sciences, University of Queensland , St Lucia, Qld; (5) Scottish Universities Environmental Research Centre, East Kilbride G75 0QF, UK.

The timing and nature of Termination 2 in the central Mediterranean basin inferred from an Italian stalagmite

The Last Interglacial is a period of great interest in Quaternary studies because it represents the most recent interval when Earth's climate was ~similar to that of today. Unfortunately, few well-dated terrestrial records exist for this period. Here we report age, stable isotope and growth rate data from a stalagmite (CC5) from Antro del Corchia, a large, high-altitude cave (MAT = 7.5 ºC) situated near the western coastline of Tuscany, Italy. Twenty-six MC-ICP-MS Th/U ages show that the stalagmite grew intermittently between ~220 and 51 kyr. Unlike an older nearby stalagmite (CC1), which experienced breaks in growth through both the MIS 10 and MIS 8 glacials (Drysdale et al. in press), CC5 grew continuously between 170 and 90 kyr, suggesting that, regionally at least, MIS 6 was a more moderate glacial interval than the previous two.

Stable oxygen isotope ($\delta^{18}O$) measurements from the stalagmite compare favorably with those from CC1 over their brief overlapping interval, and reveal a negative relationship between $\delta^{18}O$ and global temperatures. The structure and timing of isotopic variations in CC5 display an excellent match with the Vostok δD record, a proxy for air temperatures over Antarctica, suggesting that the stalagmite $\delta^{18}O$ has a strong 'cave temperature' component. The isotopic pattern, together with the growth rate data, indicate a rapid transition between ~130-128 kyr, in good agreement with the oldest reliable coral ages for the MIS 5e high stand. The close resemblance between CC5 $\delta^{18}O$, Vostok δD and several SST records from both sides of the equator suggest that Termination 2 occurred more or less synchronously in both hemispheres.

References

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Elwood Cecilia*

Department of Geography and Environmental Science, Monash University, VIC 3800

A discontinuous late-glacial and Holocene vegetation record from Pine Lake, Central Plateau, Tasmania

Palynological analysis of sediments retrieved from Pine Lake, near the northern edge of the Central Plateau in Tasmania, provides a discontinuous vegetation and climate history for the last 30,000 years. Prior and during the LGM sclerophyllous and herbaceous vegetation dominate the record and, together with relatively high values for Chenopodiaceae, suggest dry and cold conditions. However, the climate was not extreme enough to prevent the survival of small rainforest patches; probably in sheltered valleys below the Great Western Tiers. The lack of aquatic taxa, combined with minute representations of ferns and consistent but low presentation of swamp taxa, seems to suggest that Pine Lake was from about 30,200 to 19,000 cal y BP merely a small bog or swamp. The sediment appears to have been kept in situ and moist enough to prevent excessive oxidation of palynomorphs due to it having accumulated in a crack between large dolerite boulders. Such blocks not only cover the bottom of present-day Pine Lake but also occur as extensive block streams on the slopes to the west of the lake. The terminal Pleistocene and Holocene part of the record appears to be very compressed and is most likely truncated. However increased availability of water – and the transformation of "Pine Bog" into a body of water - is suggested by dramatic increases in

fern and aquatic values, and moderate rises in rainforest representation. This interpretation is supported by the charcoal record, which drops to the lowest level for the record and the maximum representation of Cupressaceae (most likely *Athrotaxis curpressoides*); taxa that thrive in moist (and cold) conditions. Tight dating control, through Pb-210 sedimentation rate determination, of the uppermost 10 cm of the record indicates that each sample provides a 6.5 year window into the vegetation history of this area. The appearance of *Pinus*, introduced *Rumex* and *Plantago* from about 1878 provides direct evidence for the presence of Europeans, whereas the fluctuations of native taxa during this period most likely reflect land use changes (logging, grazing, farming) rather than climatic variability.

English Pauline*

CSIRO Land & Water, GPO Box 1666, Canberra 2601

The environmental context and origin of salinity in Australia

The environmental context of Primary and Secondary Salinity in Australia has largely been researched as separate disciplines during recent decades. Primary Salinity − or *Natural Salinity* − is represented by widespread salt lake (playa) systems that have evolved across the continent over geologic time scales in response to climate change during the past 500 ka years, particularly the arid cycles of the last 100 ka. Secondary Salinity − or *Induced Salinity* − is the result of landscape disturbance within the historic period, approximately the last 150 years, particularly salinisation in response to broad-scale clearing of native forests for agricultural development.

The investigation of Australia's widespread playa systems has been the domain of Quaternary geoscience and academia and has traditionally been based on the disciplines of sedimentology, stratigraphy and geomorphology. Latterly, this research effort and our understanding of the origins of salinity in the landscape have benefited from the application of the latest geochronological techniques. In contrast, the investigation of secondary salinity − relatively recent salinisation of our agricultural lands, river networks, natural wetlands and rural infrastructure − has largely been the domain of State government natural resource management departments and Commonwealth science agencies. The latter has been driven more from a hydrogeological perspective with the aim of mapping the nationwide distribution of groundwater flow systems, depths to watertables and groundwater salinity concentrations. This approach is currently being directed towards predictive modelling and catchment management planning to offset or ameliorate future salinisation of economic and environmental assets.

There is a need to better integrate the core findings and understanding derived from both Primary and Secondary salinity research efforts. The relationship between topography, geomorphology and groundwater is fundamental to the processes that drive both the evolution of Quaternary salt lake systems and the salinisation of recently perturbed agricultural landscapes. Thus, the three-dimensional framework of this ancient, relatively flat and intrinsically saline continent provides the basis for this understanding and integration. Important here is the distribution and evolution of palaeovalleys and palaeolakes as the topographic depocentres where shallowing groundwaters first emerge and where salinity manifests itself. This framework needs to incorporate knowledge about temporal behaviour, i.e., the fourth dimension. Additional to the ages of our landforms and the dynamics of climate change through time, this dimension includes the antiquity of salt stores and groundwater residence times. Both these components are legacies of key Quaternary processes rather than merely the consequence of land use change in the historic period.

Only within a four-dimensional framework can the magnitudes and trends of hydrologic disequilibrium (surface water inputs/outputs and groundwater recharge/discharge) and salt disequilibrium (salt inputs/outputs) that lead to salinisation of our lands and waterways be comprehended.

Fink, David*

ANSTO Environment, ANSTO, PMB 1, Menai, NSW 2234 Australia

In-situ cosmogenic radionuclides - is this as good as it can get?

The conversion of an AMS isotopic ratio, such as $^{10}Be/^{9}Be$, to an in-situ cosmogenic concentration (10Be atoms/g quartz) and subsequently, to a useful and reliable spatial or temporal rate parameter that adds to our geomorphic and/or geochronological understanding of the earth system, requires a systematic step-wise process of data reduction. This involves careful considerations to a number of model-dependent correction factors, such as calibration production rates and choice of atmospheric and latitudinal cosmic-ray flux scaling to sample locations. Another set of issues relates to site-specific correction factors that must be considered that alters the assumed "full-sky" cosmic ray irradiation of the sampled rock surface (ie horizon shielding, till, snow and vegetation cover, rock surface erosion, etc). Sample thickness and surface orientation, particularly for steep slopes, alters the cosmic flux penetration profile, and hence production rate. Moreover, the assumption of constant geomagnetic field intensity and pole position over the exposure period can cause serious over-estimates of exposure ages. In addition, the omission and misuse of uncertainties in reporting of final age (erosion) errors requires attention. Despite these issues, it may appear to the uninitiated that the technique of cosmogenic exposure age dating is approaching the status now bestowed on radiocarbon dating. To the practitioner, on the other hand, the waters are a little more murky. So in essence, although we've come a long way, the pertinent question to ask is how good is exposure age dating – or perhaps more appropriately, for some, can it get any better?

Fletcher, Michael*

SAGES, University of Melbourne, Parkville, Victoria 3010

Boco Valley: A glimpse of pre-Aboriginal western Tasmania

Sediments analysed for pollen and charcoal content from the Boco Valley in central western Tasmania indicate that fire sensitive Huon Pine (*Lagarostrobos franklinii*) rainforest grew on the site *ca*. 85 KyrsBP, prior to the LGM (*ca.* 18,000 KyrsBP). Fire was virtually absent from the catchment area at this time also. Huon Pine, a climax rainforest species, now has a much restricted range, being confined to riparian sites close to the coast and in disjunct relictual stands (most notably at Lake Johnson in the central west of Tasmania).

The site is currently occupied by fire promoted Buttongrass (*Gymnoshoenus sphaerocephalus*) Moorland, the dominant vegetation community in western Tasmania. Buttongrass Moorland has previously been considered to be an artefact of late-Holocene climatic deterioration allowing Aboriginal people to return from their early Holocene, climatically driven exile to the coast by the expansion of dark, impenetrable and resource poor Cool Temperate Rainforest. Subsequent late-Holocene burning removed rainforest from much of west and southwest Tasmania facilitating the dominance of moorland and the evolution of the contemporary landscape.

Work completed in my PhD suggests that there has been little change in the vegetation mix of western and southwest Tasmania throughout the Holocene, allowing for the possibility of continuance of occupation and country keeping by Aboriginal groups throughout the Holocene.

The new findings in the Boco Valley shed light on what the vegetation of the region was like prior to Aboriginal arrival, further supporting the notion that people maintained a presence in the interior of western Tasmania and that the present landscape is an artefact of continued management throughout the Holocene.

Gibson, John AE* (1,2); Swadling, Kerrie M (2); Cromer, Louise (2); Bayly, Ian A E (3); Bissett, Andrew (2)

(1) Institute for Antarctic and Southern Ocean Studies, University of Tasmania, Private Bag 77, Hobart, Tasmania 7001; (2) School of Zoology, University of Tasmania, Private Bag 77, Hobart, Tasmania 7001; (3) School of Biological Sciences, Monash University, Victoria, 3800

The origins of freshwater fauna of Antarctic lakes

Most Antarctic freshwater lakes contain a selection of invertebrate animals, including nematodes, rotifers, tardigrades, and crustacea. The origins of the fauna are unclear. It has been argued that complete glaciation of the Antarctic continent at the last glacial maximum destroyed all freshwater habitats, implying recolonisation of the lakes from extra-continental sources over the last 12 000 years. However, glaciation is now known not to have been complete, and it is probable that vicariance has also played a role. We have used three approaches to infer origins for the fauna. Firstly, we have studied the morphology of copepod species currently found in East Antarctic lakes, and have found indications of long association with the Antarctic continent possibly dating back to the separation of the continent. Secondly, we have studied the distribution of animal remains in sediment cores, which has allowed us to look at the timing of colonisation of lakes by the fauna and other aspects of community structure. A consistent trend has been the appearance of moderately complex communities soon after the initial formation of a lake. Finally, we are developing molecular genetic techniques to compare individuals from different populations both in modern and ancient communities. Here we will discuss some of the results from these studies and their implications for the origins of the Antarctic freshwater fauna.

Haberle, Simon* (1); Tibby, John (2); Dimitriadis, Sophia (3); Heijnis, Henk (4)

(1) Department of Archaeology and Natural History, RSPAS, Australian National University, Canberra, ACT 0200; (2) School of Geographical and Environmental Science, University of Adelaide, Adelaide, SA 5005, Australia; (3) School of Botany and Zoology, The Australian National University, Canberra, ACT 0200, Australia; (4) Australian Nuclear Science and Technology Organisation, PMB 1, Menai, NSW 2234, Australia.

The impact of European occupation on terrestrial and aquatic ecosystems dynamics in an Australian tropical rainforest

In this study we explore the potential of combining fine-resolution palaeoecological proxies for terrestrial and aquatic ecosystems at the same locality to investigate the impacts of changing land use, fire, and climate on a tropical rainforest catchment in northeastern Australia. Lake sediment mud-water interface cores were collected at 1cm intervals to a depth of 100cm from Lake Euramoo on the Atherton Tablelands of northern Queensland. The sediments have been dated using Pb-210, C-14 and first appearances of exotic pollen (*Lantana*, *Mimosa*, and *Pinus/Plantago*). The sediments were then analysed for pollen, charcoal, diatom, chironomid and inorganic content. The combined analysis shows that the present mosaic of vegetation types in this region is a complex function of environmental changes operating across a range of spatial and temporal scales: millennial climate change, short-term climatic variations associated with El Niño events, and a shift from indigenous to “European” land use practices. Major ecosystem shifts reflected in alterations in terrestrial and aquatic taxa dominance occur soon after the occupation of the region by Europeans in the 1880's. The establishment of a World Heritage reserve in the lake catchment and the suppression of fire over the last 50 years has not restored the terrestrial or aquatic ecosystem to its pre-European state.

Haberle, Simon* (1); and OZ-INTIMATE Members

(1) Department of Archaeology and Natural History, RSPAS, Australian National University, Canberra, ACT 0200

Outcomes of the 2004 OZ-INTIMATE Meeting, ANSTO, Lucas Heights, NSW, Australia

The objectives of the inaugural OZ-INTIMATE meeting held at ANSTO in September 2004 were: (1) identify and prioritise Australian onshore and offshore reference records for the OIS

2/1 transition, and (2) promote ways to effect high-precision and dating of key Australian onshore and offshore records for the determination of a regional event stratigraphy. At the meeting there was unanimous agreement between the c. 26 attendee's that a poster be produced by the OZ-INTIMATE community for discussion at the December meeting of AQUA. The poster deals with continuous proxy records spanning 30 ka to late Holocene and contains the Law Dome Antarctic and GRIP (INTIMATE) Northern Hemisphere Ice records for comparative purposes. Data has been contributed from workshop attendees who volunteered their data. The poster will form the template for an event stratigraphy-focussed outcome derived from key continuous proxy records spanning early Holocene to c. 30 ka. Fragmentary terrestrial records (i.e. glacial advance/retreat, fluvial sequences, peat accumulation) have been incorporated where appropriate and quantitative estimates for key time periods (i.e. LGM SST's) are also included. Development of an event stratigraphy for the OZ and NZ based records will be a longer term process that is the aim for presentation at the 2007 INQUA Cairns symposium, though an event stratigraphy should be developed well in-advance of the Cairns meeting.

Hammond, Andrew P* (1); Palmer, Alan S (2)

(1) Centre for Riverine Landscapes, Faculty of Environmental Sciences, Griffith University, Nathan, QLD 4111; (2) Soil and Earth Sciences, Institute of Natural Resources, Massey University, PO Box 11 222, Palmerston North, New Zealand

Soilscapes and Late Quaternary landscape evolution of western Hawkes Bay, New Zealand using tephras as a time control

The architecture and subsequent sculpturing of the western Hawkes Bay landscape of New Zealand has been subject to a complex interplay between tectonic, climatic, fluvial, aeolian and volcanic regimes. Hawkes Bay lies westward of an obliquely convergent offshore plate boundary, the Hikurangi Trough. Onland landscape elements exhibit classical island arc terrains from west to east: accretionary wedge, forearc basin, frontal ridge and a volcanic backarc basin.

Major cycles of landscape stability/instability are associated with Quaternary climate changes. During glacial and stadial times intense physical weathering prevailed within the ranges. Weathering products were transferred via the fluvial and aeolian systems to the plains and ultimately the ocean. Interglacial and interstadial times were marked by a predominance of chemical weathering (palaeosols) and river degradation. The net result was landsurface stabilization before the next episode of instability. Earthquakes, fires (both natural and man-induced), periodic cyclonic storms and ignimbrite sheets punctuate and complicate the climatically induced Quaternary cycles. The record for these non-climatic variables is often local and may mask or even destroy the imprint of older, more poorly preserved climatically induced Quaternary stability/instability episodes.

The timing of stability/instability cycles is facilitated by: layered loess coverbeds; aggradational and degradational surfaces; palaeosols and unconformities interbedded with or bounded by well dated rhyolitic and andesitic tephra chronohorizons and ignimbrites identified as being derived from the Taupo Volcanic Zone. An onshore chronology of landscape-forming events will be presented. These are correlated to both onshore and offshore cores.

Hearty, Paul J*

School of Earth and Environmental Sciences, University of Wollongong, Wollongong NSW 2522

Warm interglaciations, abrupt environmental change, and the Antarctic "Wild Card"

Sea-level records for marine isotope substages/stages (MIS) 5e and 11 have been derived from coastal outcrops in Bahamas, Bermuda, Hawaii and Western Australia. In most marine proxy records, MIS 11 and 5e are considered to be the warmest and longest interglaciations of the past million years; a fact reflected in abundant field evidence of higher-than-present sea

levels. MIS 11 (427-364 ka) sea level rose by "stepping up" from +2, to +7, to +20 m (Hearty et al., 1999, *Geology* v.27:4). MIS 5e (130-118 ka) exhibited an early level at +2.5 m, followed by both negative and positive oscillations. An abrupt final rise to +6 to +9 m in MIS 5e was succeeded by "catastrophic" storms and mid-glacial conditions.

Rapid interglacial sea-level shifts suggest a possible mechanistic relationship with existing continental ice sheets. Laurentide and Fennoscandian ice sheets were minimal during MIS 11 and 5e; thus, upward sea-level shifts must be explained by loss of Greenland (*ice sheet equivalent (ISE)* of c. 6 m of sea level), W. Antarctic (WAIS; ISE = c. 6 m), and/or E. Antarctic (EAIS; ISE = c. 70 m) ice sheets. Although relatively stable, Greenland is prone to melting during warming of the North Atlantic. In contrast, the WAIS is highly susceptible to collapse. Demise of the WAIS may drawdown adjacent EAIS ice streams, accounting for potential rise of interglacial ocean levels by over 20 m. Evidence from past interglacials hint that rapid shifts in sea level and climatic instability may an integral part of a "Wild Card" scenario of a future greenhouse world.

Hellstrom, John*

School of Earth Sciences, The University of Melbourne, VIC, 3010

Constraining the timing of past glacial-interglacial transitions using stacked speleothem growth rate records from Nettlebed Cave, NZ

Many different physical and geochemical variables are commonly measured in speleothems and reported versus time as paleoenvironmental proxies, but few of them can be argued to give remotely quantitative results. One of the earliest and more robust proxies in common use is speleothem growth rate itself, interpreted in terms of speleothem formation requiring adequate water and dissolved CO2 to proceed. Growth rate records require high-density geochronology to produce convincing results, which until recently has been analytically difficult. In some regions speleothem growth rate has been interpreted as broadly correlating with average temperature through the impact of vegetation cover on soil CO2 levels, and elsewhere it can be controlled by changes in water availability as over much of Australia.

Here I report on the application of simple, high-throughput MC-ICP-MS U-Th dating to ten speleothem core samples from Mt Arthur, NZ to produce growth rate records discontinuously covering the last 250,000 years. Growth rates are calculated from the input U-Th age determinations using a Monte Carlo randomisation approach which fully accounts for all sources of uncertainty including interpolation error, producing continuous curves for growth rate and associated uncertainty. Particular attention is paid to the last 30,000 years as it includes the best understood glacial termination, corresponding to a sharp increase in growth rate in all samples examined, at ca. 14,000 years. The understanding of the significance of growth rate changes over this interval is applied to observed growth periods covering the previous two glacial terminations ca. 240,000 and 130,000 years.

Hendy, Chris* (1); Cooke, Penny (1); Hogg, Alan (1); Lowell, Tom (2); Preusser, Frank (5); Newnham, Rewi (3; Vandergoes, Marcus (4)

(1) School of Science, University of Waikato, Hamilton, New Zealand; (2) Department of Geology, University of Cincinnati, Cincinnati, Ohio, USA; (3) Department of Geography, University of Plymouth, Plymouth, U.K; (4) Climate Changer Institute, University of Maine, Orono, USA; Department of Geography, University of Koln, Koln, Germany.

Progress in linking marine and terrestrial records of climate change in the Southern Alps of New Zealand over the past two glacial-interglacial cycles

Sediments from several bogs and small lakes located in close proximity to the margins of Late Quaternary piedmont glaciers in South Westland show well dated pollen records indicating fluctuating extent and activity of glacial outwash. The pollen record shows a strong correlation with independently dated silt accumulation in the Bounty Trough to the east of South Island. Marine oxygen isotope stratigraphy provides a correlation with the global oceanic signal

showing a closely coupled ocean-atmosphere-terrestrial system in mid southern latitudes that is broadly synchronous with the Northern Hemisphere.

Hesse, Paul*

Department of Physical Geography, Macquarie University, Sydney, NSW 2109

Long Quaternary records of wind strength from northern and southern Australia

The size of dust deposited in deep-sea sediments provides a relative measure of wind strength -the most direct measure available. Previous results from 2 Tasman Sea cores (Hesse and McTainsh, 1999, Quat. Res. 52:343) showed that there was no change in dust size over the last glacial termination and, therefore, no evidence of stronger westerly winds during the LGM. New results from the Tasman Sea, covering the last 150,000 years, and the east Indian Ocean, covering the last 300,000 years. In fact, there is little systematic temporal variation in dust size (beyond the limits of analytical uncertainty) at the time-scale of glacial to inter-glacial intervals. This uncertainty may be large, however, because of the necessity to 'un-mix' the biomodal dust particle size distributions.

The implications of these findings are firstly that, at least for the Australian mainland and nearby oceans, variation in average wind strength in the Late Quaternary is not a valid part of the interpretation of other climate changes. For example, desert sand dunes are limited in their activity/mobility by factors such as stabilising vegetation. Perhaps more importantly, these findings allow us to better understand the nature of the re-organisation of atmospheric circulation and air masses as climates change: geographic changes in the paths and extent of wind systems occur at regional scales and were relatively limited in the Australian region, while temperature, humidity and air chemistry change more broadly and may well have had more profound impacts on the Australian climate.

Hughes, Matthew W* (1); Almond, Peter C (1); Roering, Joshua J (2)

(1) Soil and Physical Sciences Group, Division of Agriculture and Life Sciences, Lincoln University, Canterbury, New Zealand; (2) Department of Geological Sciences, University of Oregon, U.S.A.

Quaternary environmental changes influence soil transport rates on a dissected loess mantled terrace

Changes in erosion and sedimentation rates throughout the Quaternary are often attributed to climatically induced vegetation changes on hillslopes. In this study we directly test the relationship using the record from an infilled hollow in a loess mantled landscape. Previous work in the study area indicates disturbance-driven soil creep is the dominant soil transport process. We used phytolith analysis to reconstruct vegetation changes during infilling, and horizons of known age to quantify infilling rates. The hollow has infilled from sediment transported from hillslopes rising to interfluves formed by remnants of an aggradational terrace now mantled by three loess sheets. Kawakawa tephra (26.5 k cal. years) occurs as a primary depositional layer at ~85 cm depth in the upper loess sheet. Hollow infilling during the Last Glacial Maximum (LGM) occurred coevally with aeolian loess accumulation, and subsequently during the Holocene when aeolian accumulation was negligible. Phytolith analysis in the hollow shows grassland dominated during the LGM to be replaced, at about 9 ka (from regional pollen data), by forest. Sediment thickness between the Kawakawa primary emplacement horizon and depth of the uppermost grassland/forest transition was used to calculate the infilling rate under grassland. The grassland/forest transition depth was used to calculate the infilling rate under forest. Hollow infilling rates under grassland and forest are 0.05 mm yr^{-1} and 0.1 mm yr^{-1}, respectively. Increased tephra concentration in the hollow fill deposits after Holocene forest established and the greater infilling rate indicate deeper soil mixing and greater transport under forest.

Jansen, John D* (1); Bishop, Paul (1); Hoey, Trevor B (1)

(1) Centre for Geosciences, University of Glasgow, Scotland

Postglacial knickpoints in Bedrock Rivers, Scotland

Knickpoints (steepened reaches) in bedrock rivers are key agents in communicating base level change across the landscape. In so far as the time taken for a knickpoint to propagate through a river network defines the system response time, these transient, disequilibrium forms reveal much about the dynamic feedback between base level, river incision and relief development. This field study examines river response to rapid, continuous base level fall (~10–0.5 mm/a) associated with glacio-isostatic rebound following retreat of the Late Devensian icesheet from northern Britain. Using local relative sea level curves to provide a record of base level change over the past 15 ka, knickpoint style and celerity is examined in 32 rivers of east and west Scotland (drainage areas: 1–180 km^2). Knickpoint position is found to be strongly discharge-dependant in large rivers; whereas, knickpoints in small rivers tend to stall thereby transmitting a diminishing proportion of base level fall upstream. We also observe an apparent decline in knickpoint celerity over the Holocene possibly due to diminishing postglacial sediment supply. Given Scotland's E-W relief asymmetry and strong precipitation gradient, we discuss the implications of our findings for the role of climate in bedrock incision more generally.

Johnston, Rochelle *(1); Kershaw, A Peter (1); Turney, Chris (2); Bryant, Charlotte (3); Tibby, John (4); Jacobsen, G (5)

(1) School of Geography and Environmental Science, Monash University, VIC 3800. (2) School of Earth and Environmental Sciences, University of Wollongong, NSW. (3) NERC Radiocarbon Laboratory, Scottish Enterprise Technology Park, East Kilbride, Glasgow, G75 0QU (U.K). (4) Department of Geography and Environmental Studies, University of Adelaide, Adelaide, SA 5005. (5) Australian Nuclear Science and Technology Organisation, Private Mail Bag 1, Menai, NSW 2234.

A high resolution, multiproxy record of the Last Glacial Maximum to Holocene transition from the volcanic lake sediments of Tower Hill, southeastern Australia

Rapid climate changes during the late Pleistocene to Holocene transition have been recognised globally. Many parts of the world (particularly the southern hemisphere) lack suitable sites and/or good chronological control, thus providing uncertainty as to the degree of synchronicity of change and the recognition of causal mechanisms. We present a detailed, multiproxy record of the transition from sediments of a scoria cone lake within the Tower Hill volcanic complex.

High resolution pollen analysis provides a picture of dry land vegetation and is combined with detailed sediment, ostracod and diatom analyses to provide details of the depositional environment. The chronology is well controlled by 32 AMS dates indicating continuous sedimentation between 22,000 and 7000 cal. years BP.

The earliest part of the record indicates a shallow brackish lake (3 º/oo) surrounded by grassland-steppe vegetation. About 17 ka cal. B.P. there was an abrupt change to saline lake conditions (4.7º/oo) and expansion of eucalypt woodlands. It's likely that a global temperature increase associated with the beginning of deglaciation resulted in an effective reduction in moisture. From 14.9 ka cal. B.P, Casuarinaceae expands, perhaps as a result of further rises in temperature. At 14 ka cal. BP, increases in temperature and precipitation and the dominance of Casuarinaceae open forest, marked reductions in steppe elements and the re-establishment of brackish water. After a slight climatic reversal at 12.3 - 11 ka cal. B.P, warm and wet Holocene conditions prevailed.

Overall, the record shows clear late glacial variability but this is difficult to relate to either Antarctic or North Atlantic patterns, possibly due to regional influences of climatic and oceanic circulation patterns and the inter-relationship between changes in temperature and precipitation.

Jordan, Greg*

School of Plant Science, University of Tasmania, Private Bag 55, Hobart, 7001

Conflicts in physical and biological palaeoclimatic evidence, a bit of Tasmaniana

Recent (and ongoing) genetic work has revealed patterns that seem to conflict with evidence of Quaternary palaeoclimates. I will discuss the consequences of these genetic and palaeoclimatic patterns in eastern Tasmania. This region is critical, because it is the most intensively studied area for genetics in Australia, and shows enigmatic distributions of species and genotypes.

Eastern Tasmania is a centre of plant endemism, with high species diversity and high numbers of species that occur nowhere else. This is in spite of evidence suggesting that it should have been a hostile environment during the last glacial, and presumably earlier glacials. This conflict can be explained by some combination of unexpectedly recent evolution, cryptic refugia, long distance dispersal of species and inadequacies in the currently available physical palaeoclimatic evidence. Each of these factors is significant in interpreting palaeoclimates.

Kaufman, Darrell*

Department of Geology, Northern Arizona University, Flagstaff AZ 86011

Overview of the Pleistocene glacial history of the Ahklun Mountains, SW Alaska

The Pleistocene glacial history of the Ahklun Mountains, SW Alaska exhibits similarities and differences with Tasmania's. The Ahklun Mountains are at higher latitude (59°N) and experience lower temperatures, but both areas are influenced by maritime climate and the emergence of continental shelf during sea-level regressions. Both glacial sequences feature the multiple-phase expansion of ice-cap and small valley glaciers. In the Ahklun Mountains, glaciers advanced onto the continental shelf at least three times prior to the global Last Glacial Maximum (LGM). The age of the oldest drift yet identified is estimated at 400 ka based on amino acid geochronology. A subsequent advance took place about 260 ka, based on Ar/Ar dating of a tuya eruption through piedmont ice. Drift of the youngest pre-LGM advance in the Ahklun Mountains overlies lava-baked sediment with a thermoluminescence age of 70 ka, and underlies organics with non-finite (>40 ka) ^{14}C ages. Cosmogenic isotopes from moraine boulders show that glaciers reached their maximum late Pleistocene extent early during the last glacial cycle (OIS 4). Glacier advances during the LGM were much less extensive than those of OIS 4, which seems to contrast with the Tasmanian sequence. Glaciers reached their maximum LGM extent 24-22 ka, based on ^{36}Cl dating of moraine boulders and ^{14}C ages from a lake sediment core that captured the meltwater pulse of the maximum phase. The LGM is marked by several fluctuations, including a prominent readvance during the Younger Dryas, an event that apparently did not influence Tasmanian glaciers.

Kemp, Justine* (1); Rhodes, Ed (2); Spooner, Nigel (3)

(1) Division of Geography, Northumbria University, UK NE18ST; (2) Research School of Earth Sciences, Australian National University, Canberra, ACT 0200; (3)

Late Quaternary fluvial history of the Lachlan Valley, southeastern Australia

This study presents the first late Quaternary fluvial history from the Lachlan River, a 700 km waterway of the Murray Basin. Between Condobolin and Cowra three discrete fluvial systems were defined from geomorphic mapping and from hand and power augering. The Gulgo Fluvial System is characterised by an anabranching network of narrow, deep channels that were prominently leveed. One OSL date from source-bordering dune sand suggests these channels were active during MI Stage 4. They were replaced by the Ulgutherie Fluvial

System, characterised by wide and shallow, scrolled and regularly meandering channels. OSL dates from channel sand and overlying source-bordering dune sand indicates that these channels were fully established by 32,000 yr and operated continuously until 22,000 yr. Ulgutherie channel cross-sections were 6 times larger than the present Lachlan River, and bankfull discharges estimated from channel geometry formulations were 4 to 7 times larger. During the Holocene, smaller channels emerge that transported muddier sediment. The Nanima Fluvial System featured sinuous, scrolled meanders, smaller and with lower width-depth ratios than the Ulgutherie. Radiocarbon dates on Nanima deposits indicate the system was active by 6,000 yr, if not before, and was replaced by smaller, irregularly meandering channels of the present fluvial system soon after 3000 yr ago. Discharge estimates of Nanima channels indicate bankfull discharges 1.5 to 2 times the present river, suggesting that the mid-Holocene in the Lachlan catchment was wetter than today. This result is consistent with evidence for higher lake levels elsewhere in the region, but oddly, counterparts of the Nanima system have not yet been described from other Murray Basin rivers.

Kenyon, Christine E*

School of Anthropology, Geography and Environmental Studies, University of Melbourne, Victoria, Australia, 3010.

Long distance aerial dispersal of pollen from Brassicaceae crops

Brassica napus (Canola) crops have been grown in northern Victoria, to the east of Barmah Forest since the late 1980s with crop plantings slowly extending westward in recent years. It has been a major crop in the Moira Shire since 1996. A four-year modern pollen trapping program was conducted at five sites within Barmah Forest, Northern Victoria to determine local and regional plant/pollen relationships. Plant surveys within a 50 m radius of each trap were conducted to correlate with pollen trap data. Brassicaceae pollen present in the pollen traps indicate aerial dispersal occurs over at least 25 kilometres. Pollen transport distance declines with distance. Pollen influx values for Brassicaceae pollen are variable annually and between sites with peak influx at the time of crop flowering. Relative percentages of the herbaceous (NAP) pollen sum over-represent Brassicaceae plants present at a site indicating the source plants are outside the forest and are most likely adjacent Canola crops. This work has implications for the current debate on pollen dispersal of genetically modified *Brassica napus* crops and the possible contamination of non-genetically modified crops or related weedy species.

Kershaw, A Peter* (1); van der Kaars, Sander (1); Moss, Patrick T (2); Wagstaff, Barbara E (1); Sniderman, Kale (1)

(1) Department of Geography and Environmental Science, Monash University, VIC 3800; (2) School of Geography, Planning and Architecture, The University of Queensland, Brisbane QLD 4072

Climate change on orbital scales: how different is Australia?

Major features of global climate change are indicated in marine isotope records that have basic similarities throughout the world. It is generally assumed, without good dating control, that climate records derived from terrestrial sedimentary records have corresponding phase and amplitude variation. This assumption appears to be valid for most of the northern hemisphere but may break down over much of Australia. On this continent there is evidence for different forcing influences from North Atlantic, Indian and Pacific Ocean sources and that the relative influence of these forcings changes over time. There may be some similarities between Australia and South America and Africa, but longer and more securely dated records from the latter continents are required to verify them. Elucidation of these patterns is one reason for proposing the INQUA Palaeoclimate Commission project 'Land-Ocean correlation of long Quaternary records from the southern hemisphere on orbital and sub-orbital timescales'.

Maas, Roland* (1); Ihlenfeld, Chris (2); Webb, John A (2); Drysdale, Russell (3)

(1) School of Earth Sciences, University of Melbourne, Parkville, VIC 3010; (2) Dept. of Earth Sciences, La Trobe University, Bundoora, VIC 3086; (3) Environmetal & Life Sciences, University of Newcastle, Callaghan, NSW 2308

High-resolution climate records in freshwater tufa

Freshwater tufa hold much promise as high-resolution climate records: they grow in quasi-equilibrium with river water, have thick annual layers (to 4 cm), lack vital effects, contain several environmentally sensitive chemical-isotopic proxies, and can be dated by U-Th. We present the results of a high-resolution (0.5-3 month/sample) study of trace element/isotopic variations in recent and fossil tufa from Gregory River, a perennial river in the monsoon belt of NW Queensland.

A recent tufa (1985-1999) shows clear annual oscillations in trace element and C-O-Sr isotope ratios. Variations are linked to seasonal changes in water temperature ($^{18}O/^{16}O$, Mg), to the extent of upstream calcite precipitation ($^{13}C/^{12}C$, Sr, Ba, Mg), to the balance between conduit and seepage flow in upstream karst ($^{87}Sr/^{86}Sr$), and to flushing of black soils (U). All of these ultimately reflect recharge variations, i.e. interannual variations in monsoon intensity, indicating that tufas can be used as a proxy of effective rainfall. An empirical relationship between $(Mg/Ca)_{water}$ and $(Sr/Ba)_{tufa}$ permits application of the Mg-in-calcite thermometer to retrieve river water temperatures (Ihlenfeld et al., 2003 Geochim Cosmochim Acta 67, 2341).

Annual elemental-isotopic cycles in a 54 ky tufa imply a climate characterized by higher effective rainfall and lower annual river water temperature. We suggest that a wetter climate at this time is related to century/millennial-scale variations (interstadials) in monsoon intensity superimposed on Australia's overall drying trend. Fluvial tufa appear to have a remarkable signal recording ability, allowing both chemical and isotopic environmental proxy data to be retrieved with sub-seasonal resolution.

Maroulis, Jerry C (1); Nanson, Gerald C* (1); Price, David M (1)

(1) School of Earth and Environmental Science, University of Wollongong, NSW, 2522

Aeolian-fluvial interaction and source-bordering dune development over the past ~100ka on Cooper Creek, southwestern Queensland, Australia

This study provides an interpretation of interrelated Quaternary fluvial and aeolian activity on presently-muddy Cooper Creek, southwest Queensland, central Australia. The floodplain is characterised by buried sandy palaeochannels that are almost entirely invisible at the surface but are stratigraphically connected to source-bordering dunes that emerge as distinctive sandy islands through a floodplain of uniform mud. Luminescence dating has identified pronounced periods of fluvial activity represented by abundant sandy alluvium from OI Stages 8,7, 6, 5 and 3. While all these fluvial episodes were much more powerful than anything subsequent, there was declining activity during 5 and 3. Source-bordering dunes were derived from active sandy channels of late OI Stage 5 (~85-80 ka) and mid OI Stage 3 ages (50-40 ka), the channels filling with mud after each fluvial period. With sand-channel activity ceasing in late OI Stage 3 (~35-30 ka), the floodplains and channels were inundated with mud, isolating the dunes. Source-bordering dunes were widespread in Australia at times in the Late Quaternary and must represent unique climate and flow conditions that are nowhere present today. Although aeolian reworking of the upper parts of some dunes has continued until today, generally they show remarkable resilience, surviving largely without migration since OI Stage 3. While stream channels once determined the location of source-bordering dunes, in an interesting role reversal the remnant dunes now deflect, confine and concentrate overbank flows, thereby determining the position of many contemporary flood-channels and waterholes.

Marx, Samuel K* (1); Kamber, Balz S (2); McGowan, Hamish A (3)

(1) Department of Geographical Sciences and Planning The University of Queensland, St. Lucia, Brisbane, Qld 4072, Australia; (2) Advanced Centre for Queensland University Isotope Research Excellence, The University of Queensland, St. Lucia, Brisbane, Qld 4072, Australia; (3) Department of Geographical Sciences and Planning The University of Queensland, St. Lucia, Brisbane, Qld 4072, Australia

Determination of the provenance of long-travelled dust in geologic archives: A study using the ultra trace element chemistries of eastern Australian dusts

Deposits of long travelled dust are an excellent proxy for paleoclimate and may used to reconstruct regional climate and climate variability. For example, increased dust flux may indicate periods of enhanced aridity in source areas, changes in wind energy and dust transport pathways in response to changing synoptic scale circulation patterns, and land use change within the dust source areas. This type of information requires, however, that the provenance of long travelled dust deposited in geologic archives, such as ice fields, peat deposits, loess sections, lacustrine environments can be accurately determined.

A variety of methods have previously been employed to provenance long travelled dust with varying degrees of success, including grain size distribution, mineralogy, major element composition, radiogenic isotopes, zircon U/Pb age distribution, magnetic susceptibility and biological markers. Several of these methods (e.g. U-Pb zircon age distribution) often require more material than is available in high temporal resolution geologic dust archives. In addition, they have typically met with limited success where dust archives contain more than one dust source.

In this study we present results of the determination of long travelled dust provenance using ultra trace element composition determined by ICP-MS for sub-2 mg samples of dust collected from ice fields and alpine peat deposits in New Zealand. A suite of refractory trace elements has been established, whose relative abundances allow for dust fingerprinting in the Australian-New Zealand region. Binary and tertiary mixing models are employed to differentiate between local and long travelled dusts (> 2500km) while also determining provenance at geological catchment scale, a resolution not previously achieved.

McDonald, Janece* (1); Drysdale, Russell (1); Chisari, Robert (2); Hill, David (2); Wong, Henri (2)

(1) Environmental and Climate Change Group, School of Environmental and Life Sciences The University of Newcastle, Callaghan NSW 2308, Australia; (2) ANSTO Environment Lucas Heights NSW 2234 Australia

The 2002-2003 El Niño recorded in Australian cave drip waters: implications for reconstructing rainfall histories using stalagmites

Speleothems, particularly stalagmites, have been widely used as high-resolution (sub-decadal) palaeoclimate proxies (Roberts et al., 1998; Fairchild et al., 2001; Proctor et al., 2002; Treble et al., 2003). Trace element research suggests that speleothem Mg/Ca and Sr/Ca variations can act as a palaeorecharge proxy (Roberts et al., 1998; Fairchild et al., 2000; Huang et al., 2001; Treble et al., 2003) but the exact relationships between rainfall and speleothem response are complex because drip hydrochemistry can vary greatly within the same cave (Baker et al.,2000).

A 30-month study of drip water hydrochemistry from Kooringa cave, Wombeyan Caves Reserve, eastern Australia, revealed a clear geochemical response to the 2002-2003 El Niño and the 2004 drought. Through these dry periods, drip discharges fell to base flow, drip Ca2+ concentrations fell by half and drip Mg/Ca and Sr/Ca increased markedly in a covarying pattern. Such behaviour indicates the occurrence of prior calcite precipitation, a process which is linked to the availability of air-filled voids above the cave as a consequence of vadose zone de-watering.

Stalagmite calcite Mg/Ca and Sr/Ca predicted from the drip waters using partition coefficients derived experimentally under low ionic conditions displayed a marked increase through, and just beyond, the period of greatest moisture deficit. The results suggest that selected stalagmites from shallow caves in drought-sensitive eastern Australia potentially preserve a valuable record of El Niño-La Niña history which may extend back several thousand years, beyond instrumental climate records. Study of these stalagmites potentially allows placement of the existing drought record into a longer-term hydroclimatic context.

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McGregor, Helen V* (1); Gagan Michael K (2)

(1) Research Center for Ocean Margins, Universität Bremen, FB5 Geowissenschaften, Postfach 330440, D-28334, Bremen, Germany; (2) Research School of Earth Science, Australian National University, Canberra, ACT 0200;

Mid-Holocene abrupt climate shift and changes in El Niño revealed by tropical western Pacific corals

Understanding the relationship between the mean climate state and El Niño-Southern Oscillation (ENSO) is important for assessing the impact of future greenhouse warming on tropical climate. Here, we use coral proxy climate reconstructions from the Western Pacific Warm Pool (WPWP), a key player in the ENSO system, to investigate changes this relationship during the mid-Holocene.

Modern and fossil *Porites sp*. corals were drilled from Koil and Muschu Islands, Papua New Guinea (PNG) in the WPWP core region. Here, reductions in rainfall and sea surface temperature (SST) characterise El Niño events. Changes in these parameters are reflected in coral skeletal oxygen isotope ($\delta^{18}O$) and Sr/Ca ratios respectively, and from the suit of PNG fossil corals both mean surface-ocean conditions and El Niño variability can be reconstructed.

Relative to today, mean fossil coral Sr/Ca ratios from 7.3 to 6.1 ka indicate cooler SSTs, and higher coral $\delta^{18}O$ residual values suggest more saline (drier) conditions. Between 6.1 and 5.4 ka $\delta^{18}O$ residuals suggest a rapid transition to less saline (fresher) conditions. During both periods however, annually-resolved $\delta^{18}O$ show consistently reduced El Niño amplitude and frequency.

The sudden shift to fresher (wetter) conditions between 6.1 and 5.4 ka may signal a rapid initiation of moisture convergence at the WPWP, marking the establishment of a modern-like Warm Pool. The timing and nature of the rapid climate shift identified here coincides with mid-Holocene changes in the Asian-African monsoon and could represent a reorganisation of the ocean-atmosphere-land system in the tropics. In contrast, the consistent suppression of El Niño during this time suggests that the El Niño may operate independent of the mean climate state of the Warm Pool.

McKenzie, G Merna* (1); Kershaw, A Peter (1)

(1) Department of Geography and Environmental Science, Monash University, VIC, 3800.

A high resolution pollen record of the last glacial-interglacial cycle from the southeastern highlands of Victoria, Australia

A 19.6 m core from Caledonia Fen in the upper montane eucalypt forest belt has been analysed at 4 cm intervals for pollen and charcoal. The top 7 m has reasonable time control derived from a combination of AMS radiocarbon, Uranium/Thorium and OSL dates. Extrapolation of the timescale and the nature of the basal pollen spectra suggest that the record extends to the end of marine isotope stage 6. The Holocene, an isotope stage 3 interstadial and the Last Interglacial forest phases are characterized by organic sediments derived from aquatic and minor bog vegetation and the development of eucalypt forest or woodland. Between these forest phases, inorganic silty clays have generally low eucalypt percentages and high values for herbaceous plants, especially Poaceae and Asteraceae indicating a treeline below the site and substantially lower temperatures and precipitation. Within the glacial period there were several short term events of climatic amelioration marked by sharp peaks in eucalypts. Longer term 'precessional' scale cyclicity is exhibited by certain woody taxa including *Callitris, Podocarpus* and Proteaceae. *Haloragodendron, Phyllocladus* and Proteacerae appear to have been lost to the area during the recorded period. Charcoal values indicate highest burning activity during warmer and wetter periods and events, presumably because of greater fuel availability.

M^{c}Leod, Alex*

School of Geography and Environmental Science, Monash University, VIC 3800.

Spatial and temporal vegetation variation and soil processes interpreted from soil charcoal, Central Highlands, Victoria

Information on broad temporal fire patterns and vegetation responses has been gained predominantly from analysis of pollen and charcoal extracted from lake and swamp sediments. However, these studies have provided little detail on spatial patterning of fire and vegetation. This study examines the potential of measurement, identification and dating of soil charcoal to investigate the dynamics of the ecotone between wet sclerophyll forest and cool temperate rainforest along two north-south trending valley transects in the upper O'Shannessy catchment in the central highlands of Victoria. Some interesting temporal and spatial patterns are emerging from the analysis of soil pits on the south-facing slope of the primary transect. The AMS ^{14}C dates fall essentially into two age groups, one older than 33,000 and generally beyond 45,000 years BP, and the other falling within the last 2,300 years. The 30,000 year period lacking dates coincides with the Last Glacial Maximum to late Holocene period that incorporates phases of minimum and maximum forest extent. It is hypothesised that the absence of charcoal resulted initially from the sparsity of woody vegetation and then from a predominance of fire-excluding rainforest. The stratigraphic positions of the of the dates indicates within profile mixing and, when combined with particle-size analysis and charcoal concentrations, seems to imply downslope movement and the possibility of mass movement events. These preliminary results suggest that combining the study of soil processes and soil charcoal provides a new field of study for understanding patterns and causes of vegetation change.

Moss, Patrick T*(1); Kershaw, A Peter* (2)

(1)School of Geography, Planning and Architecture, The University of Queensland, Brisbane, QLD 4072; (2) School of Geography and Environmental Science, Monash University, VIC 3800

A Quaternary marine palynological record (oxygen isotope stages 1 to 13) for the humid tropics of northeastern Australia based on ODP site 820

A high resolution palynological record has been constructed from the ODP 820 marine core covering the last 500,000 years (Oxygen Isotope Stages 1 to 13). This record, and associated marine data, provides a detailed picture of environmental change (both natural and human induced) for the humid tropics region of northeastern Australia over this time period. Although sediment accumulation rates decrease with increasing age, the record appears to be largely continuous. There is a clear dominance of orbital forcing, especially at the eccentricity scale, throughout the record but each isotope stage contains some distinctive features. Superimposed on this cyclical pattern are trends or abrupt, sustained changes in the representation of many taxa and community types that may be explained by regional changes in oceanic and climatic circulation systems related to a mid Brunhes event.

Naish, Tim* (1); Pillans, Brad (2); Beu, Alan (1); Alloway, Brent (1)

(1) Institute of Geological and Nuclear Science, Lower Hutt, NZ. (2) Research School of Earth Sciences, The Australian National University, Canberra, ACT Australia (t.naish@gns.cri.nz)

Defining the Quaternary: A New Zealand perspective

The International Commission on Stratigraphy (ICS) is about to publish a new Geological Time Scale (Gradstein et al. 2004 in press) in which the Quaternary no longer has status as a chronostratigraphic unit (see www.stratigraphy.org). After discussion with the members of the INQUA executive committee at a meeting in Dublin in March this year, Brad Pillans (Chair of the INQUA Commission on Stratigraphy) has put together a proposal to "save" the Quaternary. The proposal was intended to be a compromise that would allow the extension upwards of the Neogene System, and creation of a Quaternary Subsystem within it. In proposing a Quaternary Subsystem, Brad has taken the logical step of extending the Quaternary down from its currently defined base (1.8 Ma = Pliocene/Pleistocene boundary), to the base of the uppermost stage (the Gelasian Stage) of the Pliocene Series, at 2.6 Ma, and thus, encompassing the time during which (1) Earth's climate has been influenced by bi-polar glaciation, and (2) our genus (*Homo*) first appeared and evolved. In this way the base of the Quaternary would be decoupled from the Plio/Pleistocene boundary, a boundary that has been a source of long-running discontent among Quaternarists (see papers in T.C. Partridge (ed.) *Quaternary International 40*),

The presentation is an update of the issues for the AQUA community, and a summary the various proposals for defining the Quaternary. We also address the issue of defining the Quaternary from the perspective of the New Zealand stratigraphic record of the last 2.6 Ma, and discuss biotic and climatic changes within the context of other key "global" records.

Nanson, Gerald C (1); Price, David M (1); Maroulis, Jerry C* (1); Coleman, Maria (1); Jones, Brian G (1); Bowman, Hugo H (1)

(1) School of Earth and Environmental Science, University of Wollongong, NSW, 2522

Climate and flow regime changes from ~750 ka to the present in the Channel Country of Queensland and South Australia

Sediments from Cooper Creek in the Channel Country of the Lake Eyre basin provide evidence of major climate and flow regime changes during the Mid Quaternary to Holocene. More than one hundred and fifty luminescence dates have been obtained from quartz sand in five depositional settings: floodplain alluvium; gorge alluvium; fluvial source-bordering dunes; lacustrine source-bordering dunes; and linear dunes. Extensive deposits of coarse sand and fine gravel indicate powerful rivers reworking extensive areas of alluvium some 15 to 30 m below the present floodplain surface from ~800 to ~400 ka. The limited number and resolution of dates prevents an interpretation of whether this was an episodically or continuously wet period, but abundant carbonised wood suggests extensive riparian forests. The transition between OI Stages 8 and 7 as well as the period in the middle of Stage 6 were particularly wet and enabled the river to rework its entire floodplain. A notable absence of fluvial deposition occurred between ~145 and ~120 ka corresponding to the penultimate glacial

maximum and the onset and peak of the last interglacial (OI Stage 5). Fluvial activity recommenced later in Stage 5 and again in Stage 3 but reworked far less floodplain, formed numerous source-bordering dunes, and was associated with a system of terminal or distributary lakes near Innamincka. The source-bordering dunes spawned extensive linear dunes from about 20 to 4 ka. Flow confinement through the Innamincka Dome amplified an alluvial record that faded after OI Stage 3, identifying a period of greatly enhanced flow in the early Holocene.

Pearson, Stuart*; Harvey, Sarah; Greentree, Erin; McCullough, Dale

(1) Geography and Environmental Science, University of Newcastle, Callaghan 2308, NSW; (2) Zoology, University of California, Berkeley, California 94720-3110 USA

How can information about environmental history be more useful? Tree rings and rat nests - what do they tell us about Yathong and about Quaternary science pathways?

The need for Quaternarists to prove relevance has challenged many of us to find ways of connecting with managers and other scientists. Although there are many good reasons for Quaternary sciences to inform (and be informed by) others it is sometimes hard to develop the environment for connections to be built. We started work as a collaboration to address some interesting environmental questions at Yathong (an International Biosphere Reserve south of Cobar) and the initial results of that work will be reported. Stick-nest rat middens have uncovered some important range extensions and provided a detailed temporal sequence in an area fundamentally altered by European grazing but now under conservation management. Analyses of tree rings from mallee provide some evidence for reconstructing fire history at spatial and temporal scales that are useful. Having done this initial work and becoming aware of other people working in the same region we conceived an onsite workshop that brought together a range of information users and providers. Connecting the work of Quaternarists with others is an issue that needs further attention.

Petherick, Lynda* (1); McGowan, Hamish (1); Kamber, Balz (2)

(1) Department of Geographical Sciences and Planning, The University of Queensland, St. Lucia, Brisbane, Qld. 4072, Australia; (2) Advanced Centre for Queensland University Isotope Research Excellence, The University of Queensland, St. Lucia, Brisbane, Qld. 4072, Australia.

A 25 000 year record of climatic variability for southeast Queensland reconstructed from water content and aeolian dust deposition in "dry" lake sediments

A 25 000 year record of climatic variability for southeast Queensland is currently being reconstructed from ^{14}C-dated lake sediment cores retrieved from North Stradbroke Island, Queensland. Fresh lake sediment predominantly (>80%) consists of water whose content, determined by drying (80°C/48 hours), forms a coherent trend with stratigraphy. The dry sediment mainly (>80%) consists of organic matter and a mineral fraction. Results indicate that both water content and mass of deposited aeolian dust (inferred from ash content) may be excellent proxies for the reconstruction of palaeoclimate – particularly periods of increased aridity. The location of the study site is ideal, bridging an extensive spatial gap in the current state of knowledge of palaeoclimate for eastern Australia. Analysis of samples has identified major periods of climate variability recorded in both the dust and water contents, i.e. the Mid-Holocene Climatic Optimum, the Antarctic Cold Reversal and the Last Glacial Maximum. In addition, evidence of local to regional scale climatic and/or environmental variability is emerging from the core. These results will be discussed within the context of the current state of knowledge of palaeoclimate in eastern Australia. Results from this study will potentially provide more accurate prediction of major drought events in Australia, allowing the mitigation of economic, social and environmental effects. In addition, a detailed knowledge of southern Queensland's past climate will enable more accurate prediction of future climate variability in response to natural and anthropogenic forcings.

Pietsch, Tim* (1,2); Nanson, Gerald (2); Olley, Jon (1); Price, David (2)

(1) CSIRO Land and Water, PO Box 1666, Canberra, ACT 2601 (2) GeoQuEST Research School, School of Earth and Environmental Sciences, University of Wollongong, Wollongong NSW 2522

Luminescence chronology for palaeochannels of the lower Gwydir

The large alluvial fan-plain of the Gwydir River downstream of Moree displays many well preserved palaeochannels radiating out from the fan head and formed by discharges in excess of the present regime. Forty luminescence ages comprising 10 TL ages and 30 single-grain OSL ages show their timing to corresponds closely with the chronology of Kerarbury (Gwydir 45-38 ka) and Yanco (19-15 ka) Phases established for palaeochannels on the Riverine Plain by Page et al. (1996). Comparisons are also drawn with similar studies in the nearby Namoi, Nambucca and Bellinger Valleys. Discrepancies between TL and OSL ages were obtained and could not be attributed to differential bleaching of source traps as OSL ages were older than TL ages. We infer that they result from collected samples being mineralogically atypical, and argue that the recently developed modified SAR protocol of Olley et al (2004) is the most appropriate for these samples.

Palaeohydrological reconstruction remains a particular challenge where palaeochannels do not resemble channels of the contemporary system. Planform/discharge relations taken from the literature poorly represent contemporary channels. However, the application of locally derived planform / discharge relations for discharge retrodiction is not necessarily an improvement where the sediment load differences between palaeochannels and contemporary channels is so marked. These problems not withstanding, palaeodischarges appear to have been 2 to 10 fold larger.

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Porch, Nick* (1); Sniderman, Kale (1); Jordan, Greg (2)

(1) School of Geography and Environmental Science, Monash University, VIC 3800; (2) School of Plant Science, University of Tasmania, Hobart, TAS 7001

A warm, wet early Pleistocene in southeastern Australia: The beetle and plant record from the western uplands of Victoria

Pollen, plant macrofossil and beetle assemblages from Stony Creek Basin, a small palaeolake in the Victorian western uplands, suggest the Early Pleistocene was consistently wetter and warmer than the present. This is true of rainforest intervals and periods when *Eucalyptus*, *Casuarina* and *Callitris* dominate the pollen record. Palaeoclimatic interpretation of the pollen record is complicated by the presence of a range of regionally extinct rainforest taxa (e.g., *Ilex*, cf. *Wollemia*, and several Podocarpaceae genera), combined with suspicions that the climatic ranges of some of the extant rainforest genera (e.g., *Symplocos*, *Quintinia*) are truncated, especially in southern Australia (Jordan, 1997). However, the presence of many taxa that are now restricted, in Australia, to mesotherm rainforests in New South Wales and Queensland (e.g., *Ficus*, *Araucaria*, *Agathis*, *Macaranga*/*Mallotus*, Ebenaceae), suggests a warm, wet, climate.

Beetle-based reconstructions suggest sclerophyll-dominated zones represent periods of increased rainfall, particularly summer rainfall (150-200%+), and elevated temperatures (>1^{o}C), relative to the present day values. The consistent trace presence of a range of animal-pollinated types supports the impression, from the beetle reconstructions, that climate remained at least marginally suited to rainforest at all times. Most of the data for the nature of rainforest zone climates is derived from the rich pollen record for these periods. The small beetle and plant macrofossil samples are, to date, relatively uninformative given the small

number of identified taxa. However, it may be significant that obligate microtherm beetle taxa, abundant in sclerophyll-dominated zones, are absent from the rainforest samples. This suggests the likelihood, also indicated by some of the pollen taxa (e.g., *Ficus*, Ebenaceae), that climate during rainforest intervals was as warm or warmer than during sclerophyll intervals.

Reference:
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Pucillo, Kevin* (1); Nanson, Gerald C (1); Jones Brian G (1)

(1) School of Earth and Environmental Science, University of Wollongong, NSW, 2522

Palaeochannel stratigraphy on the Riverine Plain, NSW, Australia: Evidence for higher flood discharges during the late Quaternary

A spatial database comprising over 9800 borehole logs was constructed from extensive records derived from drilling by the NSW government in the Coleambally area during the 1950's to 1970's. This data forms the framework for the current study into the distribution and origin of alluvial Riverine Plain deposits emanating from Australia's southeastern highlands. The palaeochannels (prior streams) responsible for these deposits are markedly different to contemporary rivers. The extent of relatively shallow palaeochannel deposits are fully described, building on earlier descriptions by Schumm (1968) and Page and Nanson (1996) who estimated palaeo-bankfull discharges of 4 to 8 times that of the present Murrumbidgee. However, estimates for even older and deeper prior stream deposits (~10-15m) indicate that flood discharges could have been 15 to 25 times larger than present. Sub-surface investigations reveal the presence of even deeper (10-30m), thicker and more laterally extensive successions of coarse sands and gravels below the prior stream deposits that have largely escaped mention in the scientific literature. The association of the near-surface Late Quaternary palaeochannnels with source-bordering dunes suggests enhanced seasonal snow melt from the highlands with large volumes of coarse sand carried onto the plain and deflated during periods of low flow. The older, more extensive prior stream deposits prevailed during the Mid Quaternary or before and whether source-bordering dunes were associated with these deposits is unknown.

Rhodes, Ed* (1); Magee, John (2); Fitzsimmons, Kat (2); Chappell, John (3)

(1) RSES and RSPAS, Australian National University, Canberra, ACT 0200; (2) Department of Earth and Marine Sciences, Australian National University, Canberra, ACT 0200, (3) RSES, Australian National University, Canberra, ACT 0200

Discrete periods of aeolian activity during the last glacial cycle in Australia

Many parts of Australia have little in the way of biological proxy records from which to reconstruct past environments, while aeolian landforms are common. These represent a valuable palaeoenvironmental resource, recording past changes in dune building activity. The improved chronological resolution provided by the single aliquot regenerative-dose (SAR) OSL protocol has been utilised to determine optical dates for a range of different aeolian contexts across Australia. When combined, these age estimates provide a simplified measure of the magnitude of past aeolian activity, as preserved in dune landforms. Discrete clusters of OSL dates are observed, strongly suggesting that dune building took place as a series of punctuated events, rather than continuously, even in the more arid parts of Australia. The limitations of this approach, both technical constraints and those imposed by environmental factors, will be considered, and regional patterns explored. The new data will be compared to age estimates provided by previous studies, and also in comparison to dated contexts which contain evidence for increased runoff or humidity, including fluvial sediments.

Rother, Henrik* (1); Shulmeister, James (1)

(1) Department of Geological Sciences, University of Canterbury, Private Bag 4800, Christchurch, New Zealand

Moderate climate cooling as a driver of past glaciations in hyperhumid environments of New Zealand

The timing of New Zealand's late Quaternary glacial advances has become a critical focus in the debate on interhemispheric climate teleconnections. Global synchrony of glacial advances is regarded as compelling support for a model of interhemispheric atmospheric thermal forcing whereas, asynchronous advances are inferred to support a climate link via the thermohaline circulation. Here we present results from a simple physical model showing that significant temperature cooling is not the dominant glacial driver in hyperhumid environments of the Southern Alps (NZ). Instead, the conversion of precipitation from rainfall to snowfall drives massive ice accumulation at small thermal changes (1-4°C). This effect is compounded due to the narrow width (15-25 km) of the main glacial accumulation area at the Southern Alps divide where hyperhumid conditions cause a localized strong depression on Equilibrium Line Altitudes (ELAs). The steep cross-alpine ELA gradient leads to a rapid increase of ice accumulation under moderate cooling (3-5°C) while additional cooling would produce little further glacial expansion. This glacial model is potentially consistent with emerging field evidence indicating a relatively moderate cooling during the Last Glacial Maximum (LGM) in mid-latitudes of the Southern Hemisphere. If the model is correct it implies that the limited cooling required for large scale glaciations in the Southern Alps can be generated by variations of synoptic climate phenomena requiring little or no direct interhemispheric climate forcing.

Saunders, Krystyna M* (1); McMinn, Andrew (1); Roberts, Donna (1,3); Hodgson, Dominic A (2); Heijnis, Henk (3)

(1) Institute of Antarctic and Southern Ocean Studies, University of Tasmania, Hobart, TAS 7001; (2) British Antarctic Survey, Natural Environment Research Council, Cambridge UK; (3) Environment Division, Australian Nuclear Science and Technology Organisation, Menai, NSW 2234.

Recent human-induced salinity changes in Orielton Lagoon, southeast Tasmania

Over the last 200 years the ecology of many coastal lagoons in eastern Australia have changed as a result of human activities. However, it is often difficult to distinguish natural from human-induced changes and to determine their ecological implications.

Orielton Lagoon (south-east Tasmania) is a Ramsar-listed coastal wetland of international importance for conservation. A palaeolimnological study was undertaken at the site to determine whether anthropogenic hydrological modifications to the lagoon had influenced its ecology, particularly salinity, and compromised its Ramsar status.

A diatom-salinity transfer function was constructed from a training data set of 96 diatom taxa from 34 sampling sites in 19 lagoons along the east coast of Tasmania. The salinity of Orielton Lagoon has changed in response to known engineering events, which have transformed the lagoon from an open marine environment to an enclosed, virtually stagnant brackish water body. These changes have compromised the protected coastal wetland status of Orielton Lagoon. Environmental remediation attempts have since partially restored the natural hydrology of the lagoon and it is now returning towards the state it was in prior to causeway construction.

This data set is currently being expanded and further developed to create a diatom-nutrient transfer function for Tasmanian and Victorian coastal lagoons. The transfer function will be applied to three case study areas with different degrees of human impact. The aims are to evaluate the consequences of historical nutrient changes on the ecology of coastal lagoons and the implications for the future management of south-east Australian coastal environments.

Shanhun, Fiona L* (1); Almond, Peter C (1); Shulmeister, James (2); Rieser, Uwe (3)

(1) Soil and Physical Sciences Group, Division of Agriculture and Life Sciences, Lincoln University, Canterbury, New Zealand; (2) Department of Geological Sciences, University of Canterbury, New Zealand; (3) School of Earth Sciences, Victoria University of Wellington, New Zealand

A late MIS 3 to present paleoprecipitation record from Birdlings Flat formation loess, Banks Peninsula, Canterbury, New Zealand: (1) Soil stratigraphy and chemistry

Loess on the east coast of the South Island comprises multiple sheets bounded by buried soils. Loess sheets and intervening soil units are inferred to correlate with glacials and interglacials (or interstadials), respectively. This inference, however, remains unconfirmed because of inconsistent chronologies. Furthermore, no quantification of paleoclimate has been made from these sequences: the loess contains almost no pollen, and phytoliths are poorly preserved. Birdlings Flat loess is a coarse-textured, texturally layered quartzofeldspathic loess found on the western flanks of Banks Peninsula. The present climate (MAR 700 mm) prevents pedogenic carbonate accumulating in the surface soil. However, below 2 m depth, carbonate is present in a range of forms. The loess at Ahuriri quarry has been dated by OSL, and pedogenic carbonate by radiocarbon analysis. The upper 10 m of loess accumulated in the last 35 ka and includes four morphologically-identified buried soils. All are cumulative (upbuilding) soils. Extractable Fe data generally support the morphological interpretation. The presence of carbonate, and elevated electrical conductivity relative to the surface soil, indicate that the climate under which loess accumulated was drier than today. Depth to maximum carbonate concentration decreases from >1.8 m in a late MIS 3 soil to 1.3 m in a MIS 2 soil, indicating a drying of climate. At 9 000 yr B.P. carbonate was precipitating at about 1.8 m below the soil surface, though accumulation ceased soon after. Transfer functions between mean annual rainfall and depth to carbonate will be used to estimate paleoprecipitation.

Shimeld, Peter*

School of Geography and Environmental Studies, University of Tasmania, TAS 7005

The last interglacial at Port Stephens, New South Wales

Situated 25km northeast of Newcastle, Moffats Swamp is a creation of Last Interglacial (LIG) highstand beach dunes (the present Inner Barrier dune system) that partially blocked a small valley. This initially created a drowned valley estuary with an open channel to the sea. Later this channel became partially blocked creating a brackish lagoon and as sea levels fell at the end of the LIG, the lagoon became (and remained) a freshwater wetland.

This paper will examine the rise and decline of LIG vegetation communities in and around Moffats Swamp. Pollen analysis of a 9m core has provided a record spanning the last 128 000 years. For the LIG, the record shows the development of an estuarine mangrove community (*Avicennia* with *Aegiceras*) that declined as water became more brackish. The proportion of rainforest pollen (dominated by *Dicksonia*, *Podocarpus*, *Tasmannia* and Moraceae) increased, reaching 40% of the total terrestrial pollen before declining to trace levels. The *Angophora* and *Eucalyptus* woodlands declined from 45-60% in the early LIG to trace levels by the end while Casuarinaceae increased from 10% to over 80% over this period.

This pollen record clearly shows that the Last Interglacial environment at Port Stephens was quite different from that of the Holocene. The most marked difference is the near absence of rainforest taxa and high *Eucalyptus* values in the Holocene record. Eucalypt woodlands are now extensive throughout the region and littoral rainforests are confined to small, protected patches, perhaps better described as refugia.

Shulmeister, J* (1); Rieser, U (2); Rother, H (1)

(1). Department of Geological Sciences, University of Canterbury; (2). School of Earth Sciences, Victoria University of Wellington

Aspects of the nature and timing of glaciation in the middle Rakaia Valley, South Island, New Zealand

The major glaciated catchments east of the divide in South Island, New Zealand have been the focus of glacial research for a considerable period. While the glacial morphology is well described, there has been little work on the sedimentology of the glacial deposits. Chronological control, except for the post-LGM period is also very poor. This paper presents preliminary results of chronological and glacial sedimentological investigations in the middle Rakaia valley.

At Zig-Zag quarry a pro-glacial sandur melt-out is preserved. This dates to early to mid-last glaciation (MIS3/4) and provides a true age estimate for the Tui Creek 2 advance. Final OSL ages will be presented.

At Whitecliffs, five major glacial and paraglacial units are preserved. The lowest unit is a sub-aqueously deposited till. This is overlain by glacial lake beds, which are in turn capped by chaotically deposited ice marginal sediments. The whole sequence is overlain by an Acheron (late MIS 2) till with a loess cap. The basal glacial and glacio-lacustrine beds are at least early last glaciation (MIS 4) in age and are probably much older. This is surprising as the deposits lie at the modern valley floor adjacent to the Rakaia River.

The style of glaciation suggests low surface slopes on the glacier and the likelihood that many advances simply slide across underlying gravel surfaces. This has implications both for the style of glacial features preserved and the nature of glaciations in these valleys. Both will be discussed.

Sim, Anna* (1); Heijnis, Henk (2); Mooney, Scott (1)

(1) School of Biological, Earth and Environmental Science, University of New South Wales, Sydney, NSW 2 (2) Environment Division, Australian Nuclear Science and Technology Organisation, Lucas Heights, NSW.

Use of the pollen record to investigate vegetation thickening in central Queensland over the last 120 years

Anecdotal evidence by local graziers suggested the occurrence of vegetation thickening in the desert uplands region of central Queensland over the last 50 to 60 years. This process has direct consequences for the grazing industry, leading to a reduction in palatable species and in turn, productivity.

Sediments from the semi-permanent Lake Dunn, located approximately 700km west of Rockhampton, were collected in order to investigate these claims. Pollen records from the lake sediments were used to identify vegetation change and dynamics, in particular the grass to tree ratio, over the last 120 years. These results were compared to the historical record, rainfall data, and grainsize distribution, using ^{210}Pb dating to establish a depth-time relationship.

It was found that a significant increase in Myrtaceae pollen occurred from the early 1950s, reflecting a change from continuous grass with scattered trees, to a near-continuous scrub. This increase in Myrtaceae corresponded with above average rainfall and a general change in the grazing industry from sheep to cattle.

Palaeoecological techniques have been used extensively to investigate environmental change in the in temperate and tropical regions. This study demonstrates the viability of

palaeoecological techniques in semi-arid regions with a permanent to semi-permanent water supply.

Sniderman, Kale* (1); Pillans, Brad (2); O'Sullivan, Paul (3)

(1) Department of Geography and Environmental Science, Monash University, VIC 3800; (2) Research School of Earth Sciences, Australian National University, Canberra, ACT 0200; (3) Apatite to Zircon, 1521 Pine Cone Road Moscow, ID 83843 USA

Plio-Pleistocene vegetation-fire relationships in upland western Victoria, southeastern Australia

Stony Creek Basin, a small palaeolake in Victoria's western uplands, contains organic-rich, partly laminated sediments deposited over c. 250 kyr in the latest Pliocene and Early Pleistocene. A pollen diagram shows approximately 12 cycles of rainforest/sclerophyll dominance, which are interpreted, based on an age model derived zircon fission track ages, palaeomagnetic analysis, and varve counting, primarily as responses to changing insolation between c. 1575 and 1830 ka. A high resolution pollen and macro-charcoal study of c. 10 kyr within and following one rainforest-dominated phase illustrates the division of the rainforest phase into an early, angiosperm dominated interval and a late, podocarp dominated interval, a pattern repeated in about half of the other cycles in the full record. Highest macro-charcoal values (in >125µm and >250µm size classes) are associated, surprisingly, with the interval of angiosperm-dominated, tree-fern rich rainforest, and lowest values are associated with a *Callitris*-dominated interval which occurs after rainforest values drop to trace levels. Of two *Eucalyptus*-dominated intervals, one is associated with high macro-charcoal, the other with low macro-charcoal. By contrast, insolation-band filtered time series comparisons of micro-charcoal and pollen taxa in the full record indicate that rainforest taxa lead charcoal by 118°-156° (= 6-8 kyr) suggesting that these mesic taxa are largely out of phase with charcoal, and by inference, with fire. A slightly closer relationship with charcoal is found for Casuarinaceae, which lags charcoal by 95° (= 5 kyr), but the closest relationship is with *Callitris*, which leads charcoal by only 6° (= 0.3 kyr), essentially an in-phase relationship.

Stevenson Janelle*; Hope Geoff S

Department of Archaeology and Natural History, RSPAS, Australian National University, Canberra, ACT 0200

A comparison of late Quaternary forest changes in New Caledonia and northeastern Australia

For several decades one of Australia's key palaeoenvironmental sites has been the long record from Lynch's Crater in the tropical northeast. One of the most compelling aspects of this record is a dramatic rise in charcoal that corresponds with a rise in sclerophyllous vegetation and a decline in *Araucaria* during the late Pleistocene. Over the years research at the site and from locations nearby have attempted to unravel the possible contributions made by people and climate change to this dramatic shift in fire regime and vegetation composition. However, it has been difficult to assess the regionality of the changes as comparable sites have not been found in the southwest Pacific.

We present a long Pleistocene record from Lake Xere Wapo in the Plaine des Lacs region in the southeast of New Caledonia. The record demonstrates how fire has a very long history in this landscape. But of greatest interest is that the decline in *Araucaria* that occurred at Lynch's Crater around 45,000 years ago is matched by a similar decline in the Plaines des Lacs region of New Caledonian. However, there are some very important differences. At Lake Xere Wapo this decline occurs in the absence of fire and in a landscape uninhabited by people. Our results therefore suggest that climate change, rather than people or fire, was the more important factor behind the *Araucaria* decline at both locations.

Stuut, Jan-Berend W* (1); Hebbeln, Dierk (1)

(1) Research Center Ocean Margins (RCOM), Bremen University, Klagenfurterstrasse 2, 28359 Bremen, Germany

Climate variability at the southern boundaries of the Namib (southwestern Africa) and Atacama (northern Chile) coastal deserts during the late Quaternary

In this study we present grain-size distributions of the terrigenous fraction of one deep-sea sediment core from the SE Atlantic (offshore Namibia) and a transect of cores from the SE Pacific (offshore Chile), which we 'unmix' into subpopulations, and which we interpret as 'coarse' aeolian dust, 'fine' aeolian dust and fluvial mud. The downcore ratios of the proportions aeolian dust and fluvial mud subsequently represent palaeo-continental aridity records of southwestern Africa and northern Chile for the last 60,000 yr. All records show a relatively wet Last Glacial Maximum compared to a relatively dry Holocene, but different orbital variability on longer time scales. Generally, the northern Chilean aridity record shows higher-frequency changes, which are closely related to precessional variation in solar insolation, compared to the southwestern African aridity record, which shows a remarkable resemblance to the global ice-volume record. We relate the changes in continental aridity in southwestern Africa and northern Chile to changes in the latitudinal position of the moisture-bearing Southern Westerlies, overprinted by tropical forcing in the equatorial Pacific Ocean.

Tomkins, Kerrie M* (1); Humphreys, Geoff S (1)

(1) Department of Physical Geography, Macquarie University, NSW 2109

Geomorphology of upland swamps in southeastern Australia and implications for interpreting environmental change

Upland swamps can provide a good record of environmental change since they act to store sediment, pollen and charcoal over long periods of time. The pollen record has been commonly used to infer changes in vegetation patterns, whilst charcoal concentrations are often interpreted to represent increased fire. Unfortunately, relatively little emphasis has been placed on the sedimentary record in upland swamps and the importance of changes in sedimentation to indicate catchment conditions and processes which may be influenced by internal and external forces such as climate. Hiatuses in sedimentation in swamps have been reported (e.g. Sweller and Martin, 2001; Young, 1986) which implies removal of part (or all) of previous records, including the pollen and charcoal record. Investigation of upland swamps on the Woronora Plateau, south of Sydney, has revealed evidence for cut and fill events. Radiocarbon dates indicate the commencement of sedimentation (Late Pleistocene - Early Holocene) and the timing of these events, but further investigation of the stratigraphy identifies changes in sediment texture e.g. sands to peat which implies further changes in catchment conditions and processes, such as a reduction in sediment supply. Additionally, the history of the swamps on the Woronora Plateau prior to the existing sediments remains unknown i.e. are these more long lived features subject to episodic flushing and refilling or did they form in the Late Pleistocene - Early Holocene in response to climatic warming. The formation of these swamps will be the focus of future investigations.

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Thomas, Ian*

School of Anthropology, Geography and Environmental Studies, University of Melbourne, Victoria, Australia, 3010.

Modern pollen in northeastern Tasmania

Abstract to be submitted.

Turney, C S M* (1); McGlone, M S (2); Wilmshurst, J M (2)

(1) GeoQuEST Research Centre, School of Earth and Environmental Sciences, University of Wollongong, Wollongong, NSW 2522, Australia. (2) Landcare Research, PO Box 69, Lincoln 8152, New Zealand

Millennial-scale climate cycles through the Holocene: A global, synchronous phenomena?

The present interglacial was until recently considered to be a period of exceptional climatic stability. Changes in the concentration of lithic grains through Holocene North Atlantic sediments, however, have now been shown to represent pervasive 900 and 500 yr cycles (loosely bundled together as a quasi-periodic '1500 yr' cycle), recording the southward advection of cold, ice-bearing waters from the Labrador and Nordic Seas. Similar quasi-cycles have now been recorded throughout the Northern Hemisphere, consistent with Dansgaard-Oeschger oscillations, suggesting a climate pacemaker, independent of glacial-interglacial cycles and anthropogenic forcing. Antarctic ice-core isotopic records provide strong evidence that this cyclicity is also present at high-latitudes in the Southern Hemisphere, supporting the contention that the changes are related to the strength of the thermohaline circulation and suggesting such events may be global in extent. To test this hypothesis, we have investigated five high-resolution Holocene sequences on a transect in the Southern Ocean that straddle important present-day climatic boundaries: (1) Eweburn Bog (49˚S 167˚E), Te Anau (South Island, New Zealand), (2) Deas Head Bog (50˚S 166˚E) (Auckland Island, Subantarctic New Zealand), (3) Deas Head Forest (50˚S 166˚E) (Auckland Island, Subantarctic New Zealand), (4) Mt. Honey/Filhol Peak Saddle (52˚S 169˚E) (Campbell Island, Subantarctic New Zealand), and (5) Homestead Bog (52˚S 169˚E) (Campbell Island, Subantarctic New Zealand). A total of 72 radiocarbon ages were obtained through the five sequences and calibrated using the Bayesian method option on the OxCal radiocarbon calibration program. Ages for the Subantarctic islands were complemented by changes in 'long-distance' pollen derived from the New Zealand mainland. Quasi-cyclic variations in surface moisture are recorded throughout the Holocene in many of the sequences. The wider implications of these results with regards millennial-scale climate change will be discussed.

Waring, Chris* (1); Griffith, David (2); Wilson, Stephen (2); Parkes, Stephen (2); James, Julia (3); Stone, David (1)

(1) Australian Nuclear Science and Technology Organisation, Environment Division, PMB #1, Menai, NSW 2234; (2) Department of Chemistry, University of Wollongong, Wollongong, NSW 2522; (3) School of Chemistry, University of Sydney, Sydney, NSW, 2006

The problem with speleothems

Speleothems hold great promise of providing high temporal resolution palaeoclimate records. Because limestone caves containing speleothems are located in a wide variety of terrestrial climatic regions differential regional climatic change may be discernable. Speleothems also potentially offer very long semi-continuous records not available from other archives. However, significant issues remain regarding the quantitative interpretation of speleothem isotopic records. Many dated $\partial^{18}O$ and $\partial^{13}C$ records reported in the literature show significant fluctuations that are able to be correlated with other records, but importantly they may vary significantly in the magnitude of the isotopic fluctuations without adequate explanation. The correlation between $\partial^{18}O$ and $\partial^{13}C$ records from a single speleothem may also inexplicably breakdown. We present here a synchronous month long record with 10 min sampling of cave atmosphere CO_2 concentration data from two different locations at Jenolan. These sites show a remarkably different pattern. One has a semi continuous high concentration of CO_2 between 2500 and 3500ppm, whilst another site shows a diurnal fluctuation pattern between 500 and 5000ppm. We interpret these data to indicate two end members of a continuum in ventilation styles from purely drainage to fully ventilated. A speleothem grown in differently ventilated locations will have a significantly different isotopic record. These differences probably also relate to the preference of researchers to avoid so called 'kinetically affected' samples which have grown rapidly with a strong $\partial^{18}O$ and $\partial^{13}C$ correlation, presumably in well ventilated sites. Another continuous 2 week record of cave atmospheric $\partial^{13}C$ – CO_2, H/D –

H_2O, CH_4, T, humidity and external cave meteorological data is also presented to enable interpretation of cave isotopic fluctuations. This aversion to kinetically affected samples may be unfounded, discarding a much stronger but perhaps more complex coupling between the external climatic conditions and accumulated speleothem isotopic record from well-ventilated sites.

Westaway, K E* (1); Gagan, M K (2); Zhao, J-x (3); Chivas, A R (1); Roberts, R G (1)

(1) GeoQuEST Research Centre, School of Earth and Environmental Sciences, University of Wollongong, Wollongong, NSW 2522, Australia; (2) Research School of Earth Sciences, Australian National University, Canberra, ACT 0200, Australia; (3) Advanced Centre for Queensland University Isotope Research Excellence, Department of Earth Sciences, University of Queensland, Brisbane, Qld 4072, Australia

Reconstructing palaeoclimates and environments during human occupation, either side of Wallace's Line, Indonesia: Preliminary results from speleothems

Speleothems are well suited to determine palaeoclimatic and palaeoenvironmental changes that may have impacted on human populations. This is especially pertinent in regions where climatic and environmental changes have greatly influenced the archaeology, such as in Indonesia. Very few speleothem studies have been conducted in Asia, with none of significance in the Southeast region, which is surprising considering the palaeoclimatic potential of this terrestrial proxy and the accepted importance of this region to the global climatic system.

Liang Bua (western Flores) and Song Gupuh (east Java) are key sites in the Indonesian archaeological record, providing evidence of human arrival, occupation, development and dispersal either side of a major biogeographical divide, known as Wallace's Line. These Miocene karst regions are replete with extensive speleothem sequences, providing a potentially valuable insight into the environmental conditions experienced by the early occupants of these caves. Three contemporaneous speleothem records from different cave systems situated within the vicinity of Liang Bua and Song Gupuh have been analysed for carbon and oxygen isotopes, and dated by TIMS U-series dating methods, providing a rare glimpse of palaeoclimatic and palaeoenvironmental changes occurring within the Indo Pacific Warm Pool region between 47 and 6ka. The results suggest that drying into the LGM was not synchronous between Java and Flores, with the climate of the later more sensitive to changes in precipitation. Differing regional effects may have influenced these changes, which combined with extensive palaeoenvironmental changes recorded in Java around 17ka, may have directly influenced the hominins occupying these sites. Preliminary results will be presented at the meeting

White, D Christopher*

Department of Geography and Environmental Science, Monash University, VIC 3800

Climate change and environmental response in southeastern Australia: A palaeoecological record from Lake Surprise, Western Plains of Victoria

The long held view that climatic changes have been globally synchronous is becoming increasingly questioned, and there is a need for high resolution Australian records to contribute to this debate. The numerous freshwater lakes on the western plains of Victoria provide one of the few opportunities in Australia to produce records not affected by discontinuity of sedimentation, or stream inflow or outflow events. Although the region has been intensively researched, and the scale of current research has been extended from the Holocene to embrace much of the last million years, many questions remain about the pattern of climate change over the last glacial cycle. Resolution of the debate of the timing and scale of climate change may be crucial for providing an explanation to patterns of human migration and settlement in this country. Lake Surprise is one site that has the potential to produce a high resolution record covering a large portion of the human occupation of Australia. The site is well located to address human settlement questions, being situated within the region that

spawned the intensification hypothesis of Aboriginal occupation. Presented here are initial results of a proposed high resolution, multiproxy study of Lake Surprise expected to cover the last 30,000 years.

White, Duanne* (1); Gore, Damian (1); Fink, David (2); Ferguson, Rob (1)

(1) Department of Physical Geography, Macquarie University, NSW 2109; (2) Environment Division, ANSTO, PMB1, Menai NSW 2234.

Constraints on the Charybdis and Lambert Glaciers from cosmogenic isotope dating at Loewe Massif, East Antarctica

The detailed geometry of the East Antarctic Ice Sheet (EAIS) is poorly understood over many timescales, including the deglaciation following the global Last Glacial Maximum (gLGM). Improved knowledge of this feature may lead to better understanding of both the contribution of the EAIS to eustatic sea level, and its response to atmospheric and sea level forcings. Where suitable nunataks protrude from the ice sheet, cosmogenic dating of moraines and trimlines is an excellent tool with which to constrain the height and profiles of former ice maxima, and the timing of change during deglaciation. This information also provides important constraints for numerical simulations of the EAIS and global climates.

For this purpose, a study of the glacial history of the Loewe Massif region has been undertaken. This area, on the flanks of Lambert Glacier-Amery Ice Shelf which drains ~18% of Antarctic ice, is likely to record significant changes in former ice heights. Glacial erratics and bedrock samples were collected along a transect from near sea level to ~1 km altitude, and dated using cosmogenically-derived ^{10}Be and ^{26}Al.

The exposure ages we determined have been tied to depositional units defined by their sedimentological and weathering characteristics. We found that the upper limit of the last local glacial maximum (lLGM) was <100 metres above the present glacier surface, with retreat occurring between 15±1 and 11±1 ka. An exposure age indicates that the summit (at 1050 masl) has remained largely exposed for 1.1±0.1 Ma and had an extremely low erosion rate (0.4 mm/ka), which supports evidence of regional glacial lowstand from Prydz Bay, where the drilled sediment record indicates the ice marginal retreated from the outer shelf during this time. Also, erosion rates along a low altitude (200 m) scarp indicate relatively rapid erosion with respect to the summit, with rates of 12-26 mm/ka for semi consolidated sediment, and 7 mm/ka for doleritic bedrock.

Williams, Paul W* (1); King, Darren N (2); Zhao, Jian-xin (3); Collerson, Kenneth D (3)

(1) School of Geography and Environmental Science, Auckland University, New Zealand; (2) National Institute of Water and Atmospheric Research, Auckland, New Zealand (3) Advanced Centre for Queensland University Isotope Research Excellence, Brisbane, Queensland

Composite δ^{18}O and δ^{13}C speleothem records from 25 ka until present from South Island, New Zealand – was there really a global YD?

O and C data from 8 stalagmites plus 43 TIMS dates yield composite δ^{18}O and δ^{13}C records from ~25 ka to the present. Delta^{18}O values have a first order positive relationship to temperature and δ^{13}C responds negatively to increases in atmospheric CO_2 concentration, biological activity and precipitation.

Six climatic phases are recognized. After adjustment of 1.2‰ for the ice volume effect, the δ^{18}O record between 23-18 ka varies around -3.72‰ compared to the Holocene average of -3.17‰. Late-glacial warming commenced between 18.2 and 17.8 ka and culminated in a positive excursion between 14.70 and 13.53 ka. A significant negative excursion followed from 13.53 - 11.14 ka that throws into doubt the possibility of a global YD, because it overlapped the ACR and spanned the entire YD. Positive δ^{18}O excursions at 11.14 ka and 6.91-6.47 ka represent the warmest parts of the Holocene, but negative excursions between 6

- 2 ka coincided with increased glacial activity in the S. Alps. A positive excursion from 0.71-0.57 ka was slightly later than the Medieval Warm Period.

Delta ^{13}C values were high until 17.79 ka after which there was an abrupt decrease to 17.19 ka followed by a steady decline to a minimum at 10.97 ka. The abrupt decrease after 17.79 ka probably corresponds to an increase in atmospheric CO_2 concentration, biological activity and wetness at the end of the Last Glaciation. The lowest $\delta^{13}C$ values coincided with the early Holocene climatic sub-optimum when conditions were relatively wet as well as mild.

Woodhead, Jon* (1); Hellstrom, John (1); Maas, Roland (1)

(1) School of Earth Sciences, The University of Melbourne, VIC 3010

U-Pb dating of speleothems: progress towards a robust methodology?

While the U-Th decay scheme provides a widely-used chronometer for cave deposits (speleothems), its use is limited to samples <0.6Ma old; beyond this few radiometric techniques remain viable. The ^{238}U-^{206}Pb decay scheme offers an interesting, yet rarely used alternative in such circumstances.

This situation arises largely from a) analytical challenges involved in the measurement of extremely low Pb contents, and b) the difficulty in obtaining a range in parent/daughter ratios without encountering variable common Pb. Even with the use of ion counting, measurement of the low abundance isotope ^{204}Pb remains unfeasible. Fortunately, however, it is possible to use alternative normalisations and thus obtain age information from the measurement of ^{206}Pb, and either ^{207}Pb or ^{208}Pb only. In the case of 'clean' speleothems, extremely low levels of Th make ^{208}Pb an ideal candidate for this purpose. Using a high-sensitivity Nu Plasma MC-ICPMS, analysis of all relevant isotopes is possible using Faraday cups for reasonable sample sizes (~0.5gm), to a very high level of precision and accuracy.

Preliminary results to date indicate that, under ideal circumstances, U-Pb dating of speleothems is not only possible, but also produces excellent age resolution. However, as soon as common Pb contents increase, the viability of the method tends to diminish since common Pb is rarely homogeneous in isotopic composition. As a consequence the next analytical challenge is to develop a method for 'screening' of speleothem samples, prior to U-Pb analysis. These issues will be discussed with reference to a variety of speleothem samples.

Woodward, Craig*

Department of Geological Sciences, University of Canterbury, Private Bag 4800, Christchurch, New Zealand

Cracking the chironomid code: Developing New Zealand chironomids as a proxy for past environmental change

Chironomids (non-biting midges) are the most widely distributed and frequently the most abundant group of insects in freshwater. The chitinous remains of the larvae are frequently encountered preserved in sediments deposited in a wide range of aquatic environments. Consequently, many studies have investigated the environmental tolerances of modern species in order to use them as an analog for species found in the fossil record. By defining the numerical relationship between modern chironomid species and environmental parameters (transfer functions) it is possible to reconstruct unknown environmental parameters from quantitative counts of fossil chironomid larvae taken from sediment cores. Chironomid based transfer functions for temperature, and a variety of water quality indicators have been developed in the northern hemisphere, and have provided valuable contributions to paleoclimate research and the study and management of aquatic ecosystems. Research exploring the potential for the use of southern hemisphere fauna in quantitative paleoenvironmental reconstructions is extremely limited. Preliminary results are presented

from the study of the chironomid fauna from the surficial sediments of 40 New Zealand lakes situated between 20 and 2000m above mean sea level (amsl). Numerical analysis revealed that water temperature explained most of the variation in the chironomid species data, followed by conductivity, total nitrogen, and chlorophyll a. Therefore there is a potential for the development of a robust chironomid based temperature transfer function that will contribute to the study of climate change mechanisms in this region.

Worth, James* (1); Vaillancourt, René (1); Jordan, Greg (1)

(1) School of Plant Science, University of Tasmania Private Bag 55, Hobart 7001 TAS, Australia

Where did *Nothofagus cunninghamii* survive the ice ages?

Understanding the history of *Nothofagus cunninghamii* (Tasmanian Myrtle) is one of the keys to understanding how plants survived the ice ages in south-eastern Australia. *Nothofagus cunninghamii* is the dominant tree in most of the rainforests of Tasmania and southern Victoria. In particular, this species now grows in some areas that would have been extremely stressful under arid and cold glacial climates, including north-eastern Tasmania and much of its range in Victoria. Fossil pollen indicates unsurprisingly that the species survived the ice ages in western Tasmania, and more interestingly that it also survived the Last Glacial Maximum (LGM) in central Victoria. However, in north-eastern Tasmania, the fossil record is currently uninformative or absent. This region is biologically important because it contains many endemic species, and several earlier studies have suggested that refugia existed in the region. However, geomorphological and palaeoclimatic evidence suggests aridity in this region during the LGM, and bioclimatic analyses have only been able to predict LGM refugia for *N. cunninghamii* and other species by making assumptions contrary to the physical evidence.

Here, a range-wide study into the geographic distribution of genetic variation in the chloroplasts of *N. cunninghamii* is reported for the first time. The distribution of identified chloroplast genotypes provide strong evidence for at least one refugium in north-east Tasmania, at least one in central Victoria, and several in western Tasmania.

Yu, Ke-Fu* (1,2); Zhao, Jian-Xin (1)

(1) Advanced Centre for Queensland University Isotope Research Excellence (ACQUIRE), The University of Queensland, Qld 4072, Australia; (2) South China Sea Institute of Oceanology, Chinese Academy of Sciences, Guangzhou 510301, China

High-precision TIMS U-series and AMS ^{14}C dating of a coral reef lagoon sediment core from southern South China Sea and its environmental significance

Accurate dating of lagoon sediments has been a haunting problem, although lagoon profiles, usually with high deposition rates, have a great potential for high-resolution climate reconstruction. We report 26 high-precision TIMS U-series dates (for coral branches) and 5 AMS ^{14}C dates (for foraminifera) for a 15.4-m-long lagoon core from Yongshu reef, Nansha area, southern South China Sea (SCS). All the dates are in the correct depositional sequence, revealing a ~4000-yr continuous depositional history. The results indicate the deposition rate varied in the range of 0.8 and 24.6 mm/yr, with an average of 3.85mm/yr, corresponding to an average net carbonate accumulation rate of 4,197 g $CaCO_3$ $m^{-2}yr^{-1}$. Two fast deposition periods, one from 103 to 305 AD and the other for the last 1000 years, are identified. Episodes of elevated depositions within the last 1000 years correlated well in timing with strong storm events identified from storm-relocated coral blocks in the area (Yu et al., 2004, Palaeo3). The highest deposition rates in the 1800s may be related to the tsunamis generated by the 1833 Sumatran earthquake and the 1883 Krakatau eruption.

The combination of coral TIMS U-series ages and foraminifera AMS ^{14}C ages reveals that the radiocarbon reservoir ages (R) varied between 557 and 1042 years during the last 4000 years, which are 150 to 650 years greater than the estimated global mean of 400 yr. The

reservoir ages show a decreasing trend since mid-Holocene, consistent with those in the Pacific.

Zhao, Jian-Xin (1); Wang, Yong-jin (2); Feng, Yue-Xing* (1); Xia, Qikai (1); Gagan, Michael K (3); Collerson, Kenneth D (1)

(1) Advanced Centre for Queensland University Isotope Research Excellence (ACQUIRE), The University of Queensland, Qld 4072, Australia; (2) Institute for Coastal & Quaternary Studies, Nanjing Normal University, Nanjing, Jiangsu 210097, P.R. China; (3) Research School of Earth Sciences, Australian National University, Canberra, ACT 0200, Australia

Speleothem records for the last Glacial - Holocene transition - case studies from China and Australia

The phase relations of climate change between the Northern and Southern Hemispheres (NH & SH) during the last deglaciation - Holocene transition are important for understanding of the Earth's climatic system. However, our ability to address the question of whether or not climatic events in the SH are synchronous with those in the NH has been hindered by the lack of well-dated, high resolution, climatic archives. Increasing evidence shows that climatic changes in the SH lead those in the NH by 1000 to 2500 years, but few of such records are based on precise and accurate dates.

Here we report U-series-dated speleothem records from East China and Northern Australia, which show that oxygen isotopic excursions in a Chinese speleothem between 16.8 and 10.5 ka are well correlated in timing with climatic oscillations in the Greenland ice core records, whereas the speleothems from Northern Queensland (Chillagoe) display features somehow similar to those seen in the Antarctic ice cores. For instance, in the Chinese record, relatively rapid shifts in speleothem $\delta^{18}O$ demonstrate that the intensity of the East Asian monsoon switched in parallel with the abrupt transitions (at ~14.7, 12.8 and 11.6 ka) separating the Bolling-Allerod, Younger Dryas, and pre-Boreal climatic reversals. However, the Chillagoe records combining three speleothems with overlapping growth histories consistently reveal a double-peak cold and dry period of 10-14.5 ka, with the first peak (14-12 ka) correlating in time with the Antarctic Cold Reversal (14.0-12.2 ka). A sharp warming and wetting event occurred at 16.3 ka, much earlier than the onset of the Bolling-Allerod warm period (14.7 ka) in the NH. These findings suggest that climatic events were not synchronous across hemispheres and deglacial climatic changes were possibly driven by events in the high-latitude and polar regions, rather than in the tropical oceans.

Zhao, Jian-Xin* (1); Yu, Ke-Fu (1,2); Wei, Gang-jian (3)

(1) Advanced Centre for Queensland University Isotope Research Excellence (ACQUIRE), The University of Queensland, Qld 4072, Australia; (2) South China Sea Institute of Oceanology, Chinese Academy of Sciences, Guangzhou 510301, China; (3) Guangzhou Institute of Geochemistry, Chinese Academy of Sciences, Guangzhou 510640, China

Sea-level, sea surface temperature and salinity change in the South China Sea since mid-Holocene

South China Sea (SCS) (0-22 ºN) is climatically important for it is part of the Western Pacific Warm Pool and the moisture source region of the East Asian summer monsoon rainfall. In this study, we report over 70 TIMS ^{230}Th ages and over 500 $\delta^{18}O$-Sr/Ca-Mg/Ca data for selected corals from an emerged reef in the Leizhou Peninsula, the northern SCS in an attempt to constrain post-glacial sea-level, sea-surface temperature (SST) and salinity (SSS) changes since mid-Holocene. The ^{230}Th dates show ~70% of the corals formed during the period of 7100-6300 yr BP, and the remaining 30% corals grew periodically from 5700 to 1400 yr BP. The data suggest that multiple sea-level highstands of 3.0-3.8 m above the present sea-level occurred when the above corals formed and the timing of inferred sea-level highstands correlates well with 1450-yr cycles of ice-rafted debris events recorded in the North Atlantic.

The coral skeletal $\delta^{18}O$ and Sr/Ca records for five Holocene fossil corals and one modern coral reveal a general decreasing trend in SST in the SCS from 0.9-0.5 ºC higher at ~6,800 yr BP to 2.2 ºC lower at ~1,500 yr BP, relative to the mean Sr/Ca-SST in the 1990s (24.8 ºC). Such a decline in SST is accompanied by a similar decrease in the amount of monsoon moisture transported out of South China Sea, resulting in a general decrease in the seawater $\delta^{18}O$ values. This general cooling and drying trend was reversed in recent time as a result of anthropogenically induced global warming.

Compared with independent historic climate records, our study shows that coral $\delta^{18}O$ and Sr/Ca are reliable proxies of SST and SSS, whereas coral Mg/Ca is complicated by the ubiquitous occurrence of metastable high-Mg microbialites, yielding unrealistically low SST estimates.

POSTERS

Alloway, Brent* (1); Barrell, J A David (2); Barker, Dan (3)

(1) Institute of Geological and Nuclear Sciences (GNS), Wairakei Research Centre, Private Bag 2000, Taupo, NZ; (2) GNS-Dunedin Research Centre, Private Bag 1930, Dunedin, NZ; (3) GNS-Gracefield Research Centre, PO Box 30368, Lower Hutt, NZ

The potential for retrieving a high-resolution southern mid-latitude record of LGM to post-glacial climate change from beneath Lake Pukaki, South Island, New Zealand

Lake Pukaki is located on the eastern side of the Southern Alps and is one of three large post-glacial lakes occupying formerly glaciated troughs at the head of the Waitaki River. Dammed behind moraines formed during the LGM, the Lake Pukaki glacial trough has been a very effective sediment trap that contains a near-complete record of sediment delivery from its catchment and information on climate change since the last main retreat of ice.

To date, our collective efforts have focused on assessing the feasibility of retrieving a long sedimentary core from beneath Lake Pukaki and we have conducted seismic surveys across the lake. Recently acquired data show fine parallel reflections of lake sediment up to 400 m thickness overlying basement below the southern central portions of Lake Pukaki under c. 90-100 m of water. The reflection character suggests a relatively undisturbed sedimentary sequence implying potential preservation of a fine-scale record. We propose to core the full depth of the sedimentary sequence in order to obtain a record of unparalleled quality (annual resolution – 1 year = 3cm of sediment) of Southern Alps climate.

We are seeking to form a national & international research consortium to retrieve this high-resolution sedimentary record from beneath Lake Pukaki and document sub-decadal (annual?) scale biotic and abiotic signatures of climate history. Variations in climate proxies will assist us to construct and compare regional and inter-regional paleoclimatic signatures and rates of change. The core also provides an important linkage between adjacent glacial (i.e. Tasman) and marine (i.e. DSDP-594) records and offers the prospect, not only of making a major contribution to the knowledge of southern mid-latitude climate dynamics, but will also significantly improve our knowledge of the hydrology and climatology of South Island drainage basins.

Davies, Sarah E* (1); Turney, Chris S.M (2); Kershaw, A Peter (3)

(1) School of Archaeology and Palaeoecology, Queens University, Belfast, U.K (2) School of Earth and Environmental Sciences, University of Wollongong, NSW 2522 (3) Department of Geography and Environmental Science, Monash University, VIC 3800;

A tephrochronological framework for Northern Australia: Testing the timing of fires, El-Nino and human occupancy

The humid tropics of Australia retain a large proportion of the continent's distinctive vegetation that has evolved over geological time. The sediments of Lynch's Crater in the heart of the region provide a unique record of volcanic activity, vegetation response to global climate change, variable El-Nino-Southern Oscillation (ENSO) activity and human impact through burning from the time of their arrival on the continent (45-50,000 years ago).

Lynch's Crater is situated on the Atherton Tableland, north Queensland. Previous studies have found this site to contain a continuous and high resolution record of environmental change throughout the last two glacial-interglacial cycles (Kershaw, 1986). The establishment of an accurate and precise chronology for the sequence is essential if we are to be able to depict from the record the exact timing of earliest human occupancy in the area, and reveal any patterns or periodicity in climatic forcings, particularly as this area lies in the tropics which are now believed to play a major role in global climate.

The Atherton tablelands has over 60 volcanoes, at least ten of which are known to have erupted in the last 50,000 years (Kershaw et al., 1971, 1975) providing great potential for tephrochronological control. It is hoped that geochemical determination of tephra horizons within the Lynch's Crater sequence, and marine core ODP site 820 situated on the adjacent continental slope, will enable robust correlations between the two records and lead to an assessment of their regional significance. Tephra has the potential to provide a chronology independent of the rapid and extreme shifts in atmospheric radiocarbon content, and thus, may be used to test the accuracy of the ages already established for the core on the basis of the radiocarbon technique.

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Drysdale, Russell* (1); Zanchetta, Giovanni (2); Hellstrom, John; Maas, Roland (3); Cartwright, Ian (4); Fallick, Anthony (5); Piccini, Leonardo (6); Pickett, Matthew (7)

(1) Environmental Geoscience Group, The University of Newcastle, Callaghan 2308, Australia; (2) Scienze della Terra, Università degli studi di Pisa, Pisa 56100, Italy; (3) School of Earth Sciences, The University of Melbourne, Parkville 3052, Australia; (4) Hydrogeology and Environment Research Group, School of Geosciences, Monash University, Clayton 3168, Australia; (5) Scottish Universities Environmental Research Centre, East Kilbride G75 0QF, UK; (6) Scienze della Terra, Università degli Studi di Firenze, Florence 50121, Italy; (7) Environmental Geoscience Group, The University of Newcastle, Callaghan 2308, Australia.

A multi-proxy record of hydrological variations during the Holocene from an Italian cave deposit

In this study, the factors controlling $\delta^{18}O$ and $\delta^{13}C$ in a ca. 150 mm-thick Holocene flowstone (RL4) from Renella Cave (Tuscany, Italy) were constrained by measurements of calcite Mg/Ca ratios and fluorescence. Under relatively stable temperatures, speleothem Mg/Ca and organic fluorescence are related to rainfall. As rainfall decreases, Mg/Ca increases due to 'prior calcite precipitation', where $CaCO_3$ is precipitated in dewatered cavities in the vadose zone (Huang & Fairchild 2000). Under the same conditions, organics in the soil acquire a more fulvic character due to enhanced decomposition (McGarry & Baker 2000). These compounds are embedded in the calcite and fluoresce at relatively short emission wavelengths when excited by UV light. In RL4, the most prominent and abrupt Mg/Ca and fluorescence excursion occurs between 3.7 and 5.0 kyr, indicating drier conditions in the region during this time. Over the next ~1000 years, an opposing trend is observed in both parameters, suggesting a switch to a wetter and more stable climate. This pattern is reversed at ~2.7 kyr with a progression to drier and more variable conditions similar to those apparent for the period 7.0 to 5.0 kyr. The results suggest that the higher isotope values observed during drier intervals are due to: a reduced 'rainfall amount' effect in the case of $\delta^{18}O$ (Bar-Matthews et al. 1999), and increased input from ^{13}C-rich bedrock from longer residence time percolation waters and/or lower flow rates across the speleothem surface (which enhance the loss of $^{12}CO_2$ from percolation waters) for $\delta^{13}C$ (Baker et al. 1997; McDermott 2004).

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Feng, Yue-Xing* (1); Zhao, Jian-Xin (1); Gagan, Michael K (2)

(1) Advanced Centre for Queensland University Isotope Research Excellence (ACQUIRE), The University of Queensland, Qld 4072, Australia; (2) Research School of Earth Sciences, Australian National University, Canberra, ACT 0200, Australia

Speleothem record of periodic climatic variations in Tasmania during 128-100 ka before present (BP)

Speleothems often contain pure crystalline calcite that can be precisely and accurately dated by U-series. However, climatic interpretation of C-O isotopic variations in speleothems is complex due to combined influences of a number of competing factors. In a temperate marine setting like Tasmania and New Zealand, the temperature dependence of $\delta^{18}O$ is weak and usually positive, which may be complicated by a negative relationship between $\delta^{18}O$ and precipitation amount. Due to the lack of C4-type vegetation, $\delta^{13}C$ is dominated by biological activity and water balance with wetter conditions and higher bioproductivity leading to more negative values, despite other complicating factors.

We obtained 141 C-O isotopic data for a stalagmite from Genghis Khan cave in north Tasmania that was precisely dated to grow continuously from 100 to 128 ka BP. The results show that the growth rate and $\delta^{13}C$ are broadly correlated, with higher growth rates corresponding to more negative $\delta^{13}C$, suggesting the two parameters may be related to water balance and soil CO_2 abundance. $\delta^{13}C$ values progressively and cyclically increased from -12 to -4‰ between 128 and 110 ka BP, and then rapidly dropped by 4‰ since 109 ka. However, during the same period, $\delta^{18}O$ display no obvious trend and a smaller variation of -3.2 to -5.0‰. Nevertheless, the largest $\delta^{18}O$ negative excursion by 1.7‰ occurred within 200 years at 119.48 ka BP, within error of 119.6±0.6 ka age for the abrupt termination (<300 years) of full Last Interglacial monsoon precipitation in South China (Yuan et al., 2004, Science 304: 575-578). In addition, cyclic changes of $\delta^{18}O$ and $\delta^{13}C$ are positively correlated, suggesting that water balance and soil CO2 abundance also played a dominant role in driving $\delta^{18}O$ cycles. Spectral analysis of $\delta^{18}O$ yields statistically significant peaks at 1450, 785, 650 and 460 years. The 1450-yr cycle in the stalagmite is probably analogous to the pervasive millennial-scale climate cycle described by Bond et al. (1997, Science 278: 1257-1266; 2001, Science 294: 2130-2136).

Gouramanis, Chris*

Department of Earth and Marine Science, Australian National University, Canberra, ACT 0200

High resolution Holocene climate from southern Western Australia using ostracods

Ostracods (micro-crustaceans) have been used successfully as palaeoclimatic indicators from cores taken from most continents, including Australia, but WA remains an area still poorly studied. The work being conducted at Rottnest Island and Two Mile Lake (south of the Stirling Ranges) is part of a larger project to determine the Holocene climate from southern Australia in high resolution. As such, cores taken at Barker Swamp and Two Mile Lake are currently being analysed to determine the ostracod faunal distributions, which will be used as a first order approximation of the palaeoclimate from southern Western Australia. This will be followed by geochemical analyses of the tests, which will provide palaeoclimatic data for that part of Australia.

Currently, a vast project comprising water physico-chemical parameters and ostracod taxa is being examined so as to both interpret the lacustrine palaeoenvironment and the climate at that time. Some of these data will be presented in conjunction with Dr L. Radke's published data for southeast Australia.

Haberle, Simon*

Department of Archaeology and Natural History, RSPAS, Australian National University, Canberra, ACT 0200.

Robinson Crusoe's legacy: An environmental history of the Juan Fernández Archipélago, Chile

The Juan Fernández Archipelago lies at the very edge of the known expansion of prehistoric Polynesian peoples across the Pacific and is possibly one of the few locations that remained unaffected by humans prior to European occupation some 400 years ago. During the early period of European exploration of the Pacific the islands harboured many famous castaways including Alexander Selkirk, later to be immortalized in Danial Defoe's tale of Robinson Crusoe. Despite the importance of the Juan Fernández Archipelago to the history of human migration across the Pacific and to the development of our understanding of island biogeography and conservation there is little known about past natural and human influences on this environment.

What were the island environments like before and after the arrival of European settlers? A multi-disciplinary approach to island environmental history was undertaken using a survey of historical photographs, sediment deposits that preserve pollen, charcoal from burnt plants, and other plant fossils, and archaeological excavations. High resolution pollen and charcoal records reveal that fires were very rare prior to human occupation and conditions suitable for ignition may have only been possible during severe dry periods connected to the Pacific climate phenomenon known as El Niño-Southern Oscillation (ENSO) events. The arrival of Europeans led to the rapid destruction of forest vegetation, followed by the expansion of open vegetation and the invasion of introduced weeds such as *Rumex acetosella*. Recent strategies to revegetate degraded areas with native plants and to limit fire appears to have led to a partial return to pre-European conditions.

Hendy, Chris*

Chemistry Department, University of Waikato, Hamilton, New Zealand

Coring stiff sediments in a glacial terrain

A range of corers have been developed at the University of Waikato to obtain uncompressed core from lakes, bogs and mires in South Westland, New Zealand. The corers needed to be light, cheap to manufacture and robust enough to penetrate compact glacial silts, logs and occasional drop stones. The corers are based on commercially available medium wall 50mm stainless steel tube with a variety of pistons and driving techniques to match sediment characteristics.

Hesse, Paul* (1); Olley, Jon (2)

(1) Department of Physical Geography, Macquarie University, Sydney, NSW 2109; (2) CSIRO Land and Water, Canberra, ACT

High latitude and low latitude air mass movements over southeastern Australia over the last full glacial cycle

Australian climate is characterised by the relative importance of high latitude or low latitude weather patterns. The intrusion of tropical air masses into the south has been used to explain the pattern of palaeohydrologic change in northern Australia and the Lake Eyre Basin and has been put forward as part of the explanation of the apparent differences between the Holocene and Last Interglacial found in some proxy records. However, the impact on the complex palaeohydrological record of southern Australia remains unclear and some proposed circulation reconstructions would contradict those explanations. Did air masses mover latitudinally in response to global glaciation and in what direction?

New work from an area of southeastern Australia currently experiencing seasonal wind reversal, Old Harbour, reveals two lunettes (one dating to MIS5 and one dating to MIS3). Both were formed as the result of very similar hydrological conditions, but the older lunette was formed by deflation of the lake bed by easterly winds (as occur in summer today), while the younger lunette was formed by westerly winds (a winter time weather pattern today).
In MIS5 the tropical circulation system penetrated further south than during the Holocene and retreated north during MIS3. Northward movement of the westerly system is supported by other dated lunette dunes and linear sand dunes, continuing into the LGM. This simple response of the circulation system to global climates mirrors the pattern observed in the northern part of the PEPII transect. There remains an obvious contrast between 5e, with its lake bed deflation, and the Holocene when lake bed and lunette are both stable.

Ladd, Philip* (1); Clarke, Ian (2)

(1) School of Environmental Science, Murdoch University, Murdoch, WA 6150; (2) Royal Botanic Gardens and National Herbarium, Birdwood Ave. South Yarra, Victoria 3141.

A 1500 year pollen record from Mt Strzelecki, Flinders Island

Mt Strzelecki (756 m) is the highest peak on Flinders Island. In a saddle below the summit a 1 m deposit of peaty sand has built up over 1500 years (BP). As the Peaks of Flinders are the wettest part of Flinders Island the deposit was selected for pollen analysis to determine if *Nothofagus cunninghamii* had ever been present on the island in the time covered by the sediment. This was before BIOCLIM modeling had shown that Flinders Island is currently outside the distribution envelope for the species.

In 1979 the site was dominated by a low closed forest of *Leptospermum grandifolium* with an understorey of *Dicksonia antartica*. There is no record of *Nothofagus* except as a few grains which would be expected from long distance transport. Apart from *L. grandifolium,* wet scrub elements such as *Coprosma, Drimys, Pomaderris, Monotoca* and fern spores dominate the pollen spectra and there is no evidence of charcoal in the sediments. Surprisingly there is no record of *Atherosperma* which is present in the general area but this may be due to the poor preservation of this pollen type.Despite some fluctuations in the main angiosperm pollen types it is considered that the vegetation in the area has remained substantially unchanged for 1500 years despite the very changed conditions on the lowlands of Flinders Island over the last 250 years.

Paterson, Kristina* (1); White, Camille A (2); Gibson, John A E (1,2); Swadling, Kerrie M (2)

(1) Institute for Antarctic and Southern Ocean Studies, University of Tasmania, Private Bag 77, Hobart, Tasmania 7001; (2) School of Zoology, University of Tasmania, Private Bag 77, Hobart, Tasmania 7001

A tale of two cores: Unravelling the history of Abraxas Lake, Antarctica

Abraxas Lake is a small (7.7 ha), brackish lake (salinity ca 15 – 20 ‰) in the Vestfold Hills, East Antarctica (68°29.34'S, 78°17.22'E). Two sediment cores collected from the lake have yielded contradictory results that have made interpretation difficult. A 30 cm gravity core contained brown-orange sediment that was deposited 24 000 – 6 000 ^{14}C yr BP. No carbonate was detected in this core. The sediment contained numerous diatoms and forams in the basal section of the core, grading to an assemblage of copepod remains, eggs and other organisms in the more recent sediments. A 1.6 m piston core from the depocentre of the lake was consistently dark brown in colour, and contained abundant authigenic carbonate. The base of the core had very low water content, and was devoid of diatoms, forams and other biota. The sediment surface was dated as modern, at 15 cm 1700 ^{14}C yr BP, and at 41 cm 3100 ^{14}C yr BP. We suggest that the lake existed prior to the last glacial maximum, but was then covered by thick glacial or shelf ice for an extended period. The Holocene marine high stand did not reach the lake, and the flora and fauna presently found in the lake are derived from the pre-glacial community. The site of the short core was either exposed due to

low water level, or is now located in a non-depositional area of the lake. Abraxas Lake provides the first evidence of pre-LGM ice-free conditions in the Vestfold Hills.

Pillans, Brad (1); Alloway, Brent* (2); Naish, Tim (3); Abbott, Steve (4); Palmer, Alan (5); Westgate, John (6)

(1) Research School of Earth Sciences, The Australian National University, Canberra, 0200, Australia; (2) Institute of Geological & Nuclear Sciences, Wairakei Research Centre, Private Bag 2000, Taupo, NZ; (3) Institute of Geological & Nuclear Sciences, Gracefield Research Centre, Box 303-68, Lower Hutt, NZ; (4) School of Environmental Science and Management, Southern Cross University, Po Box 157, Lismore NSW 2480,Australia; (5) Soil and Earth Sciences, Institute of Natural Resources, Massey University, Private Bag 11-222, Palmerston North, NZ; (6) Department of Geology, University of Toronto, 22 Russell Street, Toronto, Ontario, M5S 3B1, Canada.

The distal archive of North Island silicic volcanism recorded in Pleistocene shallow marine sediments of Wanganui Basin, New Zealand

Vitric-rich volcaniclastic horizons provide an important tool for correlation of glacio-eustatic sedimentary cycles, both within the now well-described shallow marine record of Wanganui Basin, and to other terrestrial and deep-marine records in the New Zealand region. In addition, these horizons provide a well preserved distal record of major rhyolitic eruptions from the Taupo (TVZ) and Coromandel (CVZ) Volcanic Zones that is otherwise not observed and/or preserved in proximal source areas. A total of twenty-eight volcaniclastic horizons are recognised on the basis of glass shard major element geochemistry and stratigraphic position. Many horizons have been dated by a combination of magnetostratigraphy, orbitally tuned cyclostratigraphy and isothermal plateau fission track (ITPFT) ages.

Volcaniclastic horizons in Wanganui Basin appear to have been emplaced through a variety of primary and secondary processes. For primary emplacement there is evidence for direct tephra-fall as well as transitional water-supported mass flow through to hyperconcentrated flow emplacement. No gas-supported flow deposits have so far been recognised in Wanganui Basin.

Although some primary and secondary units from Wanganui Basin can be chemically and chronologically linked to known TVZ eruptions, most remain uncorrelated with proximal deposits owing to proximal source area erosion and/or deep burial as well as adverse effects of vapour phase alteration and devitrification within near-source welded ignimbrites which restrict geochemical characterisation. Despite these difficulties, a number of volcaniclastic deposits in Wanganui Basin can be reliably correlated to equivalent-aged distal sedimentary successions in Auckland Region, Hawkes Bay and in deep-sea cores to the east of New Zealand retrieved from Ocean Drilling Program (ODP) sites 1123 and 1124.

Yu, Ke-Fu* (1,2); Zhao, Jian-Xin (1)

(1) Advanced Centre for Queensland University Isotope Research Excellence (ACQUIRE), The University of Queensland, Qld 4072, Australia; (2) South China Sea Institute of Oceanology, Chinese Academy of Sciences, Guangzhou 510301, China

Mid-Holocene century-scale sea level fluctuations recorded in microatolls at Leizhou Peninsula, northern South China Sea

The microatoll, a disc-shaped coral with a dead core of flat top surface surrounded by living or dead rim(s), have been widely used as an important and precise marker of sea level fluctuations, as the death of the head in the core was often attributed to sub-aerial exposure during low tides. Recent studies also suggest that its formation was related to past earthquake or El Niño events that are also capable of causing relative water level fluctuations.

We report 16 high-precision thermal ionisation mass spectrometric ^{230}Th ages for 14 rims of 6 microatolls from an emerged reef terrace at Leizhou Peninsula, northern South China Sea, a tectonically stable area. The elevations of these microatoll rims were measured by comparing

to the national water level station about 1 km away. The results indicate that the sea level during the period of 7.1 - 6.6 ka BP was about 2.2-2.8 m above the present. However, the sea-level fluctuated within this 500-yr period, with at least 4 cycles of fluctuations (7.11-6.99, 6.99-6.89, 6.89-6.76, 6.76-? ka BP). The amplitudes of these fluctuations were about 40-60 cm. From this study we conclude that the sea level in the mid-Holocene was higher than present but was unstable on decadal-century scales.