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Quaternary Australasia

Pleistocene faunal assemblages from Henschke Cave

A palaeosalinity record from Lake Clayton

Troels-Smith adapted

AQUA 1997- Lake Eyre

Southern Connection in Chile and Argentina

Lake Mungo revisited

...and much more...

The Newsletter of the Australasian Quaternary Association

Quaternary Australasia , Volume15/2, December 1997

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Material for the next issue should reach the editor by **30th March 1997 (papers)** and **30th April (other).**

The **Australasian Quaternary Association (AQUA)** is an informal grouping of people interested in the manifold phenomena of the Quaternary. It seeks to encourage research by younger workers in particular, to promote scientific communication between Australia and New Zealand, and to inform members of current research and publications. It holds biennial meetings and publishes the journal *Quaternary Australasia* twice a year. *Quaternary Australasia* is edited by Kate Harle. The annual subscription is $A20 or $10 for students, unemployed or retired persons. President is Dr Paul Hesse, School of Earth Sciences, Macquarie University. An application form for membership can be obtained from Dr Geoff Hope (address and contact details below). Members joining after September gain membership for the following year. Existing members will be sent a reminder in December.

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James Cook - John Nott
La Trobe - Bert Roberts
Macquarie - Paul Hesse & Damian Gore
Melbourne - Ian Thomas & Christine Kenyon
Monash - Patrick Moss
Newcastle - Stuart Pearson
New England - Bob Haworth
New South Wales - Scott Mooney
South Pacific - Marie Ferland
Sydney - Stephen Gale
Tasmania - Leanne Armand?
Western Australia - Liz Pickett?
Wollongong - Brendan Brooks

New Zealand: Jamie Schulmeister

General: Colin Murray-Wallace, Bill Boyd, Peter Kershaw

The campus representatives were nominated at Lake Eyre or by the executive committee principally to transfer information to/from local members. Institutions not represented can contact Paul Hesse to be included. Individuals who don't want to be included can contact Paul Hesse to be removed from the list by nominating someone else.

Cover Illustration - Ant mound on the surface of Lake Eyre. Photo by Kate Harle

Quaternary Australasia

Contents Volume 15 Number 2

The things that happen at AQUA meetings!

Welcome to the first issue of Quaternary Australasia under my dubious editorship. I agreed to take on this role in a weak moment during the 1997 AQUA field conference at Lake Eyre (thankyou Paul!). I'm not sure whether this was due to the fantastic surroundings of Lake Eyre, the feeling of camaraderie frequently associated with AQUA conferences or the copious quantities of liquid courage of which I had partaken? My last ditch attempt to wriggle out of the responsibility by assuring Bill that if he wanted to retain the editorship I had no intention of staging a coup d'etat was foiled by his equally fervent assurance that after eight years of producing QA (and I might add producing an excellent newsletter) he was ready to retire. He sealed my fate by officially passing on the editorship in the last issue (Vol. 15/1). So here I am and here it is, my first issue! And despite all my initial groaning I must admit to having really enjoyed the experience!

I have decided to change the format of the newsletter somewhat, as you will see. This is largely due to my recent initiation into the joys of the Office 97 edition of Microsoft Word. Like my relationship with Tilia, this has an element of love/hate about it. I love the font variety and the formatting capabilities, but I hate the way it suddenly decides to take page lay out into its own 'hands' and its insistence on using American spelling even though I have clicked the English dictionary!! Anyway, this issue is in the form of a trial. I will probably experiment a bit and change things again for the next issue, so if you have any comments or ideas about the style, font, layout, etc. please let me know. As a fledgling editor I welcome your thoughts.

Whilst on the matter of style, I have a few requests to contributing authors which will make life a lot easier for me and I think in the long run for readers. Firstly, I'd like to place a limit of around 5000 words on paper lengths. Papers longer than this can be difficult to read and sometimes fall into the category of too much information. Please make use of tables and diagrams to present information, such as data descriptions, in a concise and easy to assimilate format. Secondly, if you are submitting diagrams and tables please send them to me as separate files rather than embedding them in your text. Formatting papers that have embedded diagrams has been a nightmare that I would like to avoid in the future. I also have access to a scanner if your diagrams are not in electronic format. Please make these no bigger than A4 size. Photographs are also welcome (B&W or colour). All the papers submitted will be refereed, so please nominate a relevant Quaternarist to perform this task when you submit. I, or another member of the executive committee, will act as a second referee.

This editorial would not be complete without also welcoming my fellow QA editor, Tim Barrows. Tim has agreed to take on the task of Information Technology Editor and, as well as airing his views on the Quaternary information technology scene, will be collating any technology related news. So if you have anything that you feel falls under this category, whether it be news and/or reviews of web sites, computer programs, databases or anything else technology related then please send it to Tim.

Finally, I am indebted to a few people for their assistance with the production of this issue. Henk Heijnis gave freely of his Dutch army publishing expertise and spared me not when it came to opinions on style! He well and truly earned his unofficial title of Quaternary Australasia Style Editor. Thankyou Henk! Tim Barrows, as Information Technology Editor, was also pivotal to the production of this issue (and many more to come, I hope) as was Geoff Hunt, who generously contributed several items, including a review of the last AQUA meeting. Thanks also to Paul Hesse, not only for suggesting the idea of being the editor, but also for his encouragement, his presidential words and for organising the printing. A special thankyou must also go to our anonymous correspondent from Maluku I, who provided the low down on the wanton destruction of ANH. Finally, thankyou to all who contributed to this issue. To those who didn't, I eagerly await your contributions. Deadlines are listed on the inside cover.

Last, but not least, thankyou very much to Bill Boyd for his tireless efforts in producing Quaternary Australasia for the last eight years. I only hope that I can live up to your standards.

Kate Harle
Editor

Last dance, last chance

Warm summer air bathed the glorious Edwardian Albert Hall and its torch-lit terrace while 194 ill-assorted partners lined up for a last dance with the Division of Archaeology and Natural History at the Dismemberment Event held on November 28th in Canberra.

Derived from the Departments of Prehistory, Biogeography and Geomorphology and the Radiocarbon Dating Laboratory (later the Quaternary Dating Research Laboratory), in the Research School of Pacific (± Asian) Studies at the Australian National University, ANH has been downsized, rationalised and re-re-organised into a slim outfit of three researchers within the Division of Society and Environment, RSPAS, ANU (the major output of the School is acronyms).

For anyone who doesn't know, the events came about after a nasty squabble over money within the School. Economists 1, ANH 0.

Nevertheless, three researchers live on in RSPAS and others have found homes around the ANU campus, in particular in the Research School of Earth Sciences. The most consistent story so far is that the pollen laboratory will stay in RSPAS with Geoff Hope in charge and Gill Atkins and Dominique O'Dea preparing samples etc. Dating facilities seem set to be incorporated into RSES, where John Chappell and Brad Pillans also will find a home. The fate of others is less clear to me, and possibly still to those on the ground.

Despite the trauma and the continuing uncertainty there was little rancour evident in the Albert Hall. There was some passion however. Jim Bowler's reading of the 'honour roll' of those lost in action ended a lament for the abandoned commitment among the powerful in both universities and government to know and understand the Australian environment and the relationship of people to it. At the other end of the avenue the Senate roof glowed as the Wik bill was debated.

The mood of righteous anger, of being usurped by philistines, business men and the bottom line may be familiar to many engaged in research in the natural sciences and the arts today. ANH is not alone at the ANU in being cut and ANU is not alone within Australia.

The bottom line seemed a long way from the Albert Hall and the Last Wicket Cricket match under the graceful willows of Fellows Oval the next day. Eugene Wallensky, as ever, cajoled serious efforts from otherwise casual cricketers and at some stage Colin Campbell gave an ingenious insightful analysis of its significance to a reporter from the ABC's The Science Show. In fact, listening to it in Sydney traffic, I thought I might have finally understood its terrific importance within the old Bio and Geo and regretted practicing Tai-Chi in the outfield and being tossed off the field in my only ever game.

There is nothing surer than that to maintain a place in Australian universities and to maintain research funding, Quaternary scientists will have to be more conscious of the international significance of their research, the benefits to the community of their work and promote those benefits. The new rules dictate that alliances between universities and with industry confer some strength and that 'centres of excellence' are powerful in attracting funding, positions and students. The success of groups such as those at Wollongong, RSES (a covert Quaternary operation) and Monash are good examples.

AQUA has a proud tradition (the only tradition?) of informality. As I've found recently this borders on the disorganised. Many of us have perhaps felt that we are ill-informed of the activities of other groups and individuals in Australia and the many international projects with acronyms. AQUA will never have a role of coordinating research but should have the role of enhancing communication. Presently, Quaternary Australasian has two issues a year (both hard and electronic formats) which is not ideal for the fast transfer of information but is more than a handful for the editor. We have the option of an e-mail list for Australian

From the President's Pen

Quaternarists. But, given the pain of extraction of items for QA, how many of us will use it? Hopefully next year our cyber-man Tim Barrows will rig one up and put us all to the test.

The committee elected at the 1997 Annual General Meeting has been extended by the addition of Jamie Shulmeister as 'our man in NZ' and John Dodson, in a reciprocal deal between AQUA and the National Committee for Quaternary Research of the Australian Academy of Science. The exchange of information between the two independent bodies seems overdue (see QA 13/1, 1995). By next issue I will know if there is anything to exchange.

AQUA has instituted Student Travel Prizes, advertised elsewhere in this issue, to return some of our funds to the Quaternary community and foster new talent. We have a good level of student participation now, and healthy membership overall. In the current climate it must be a concern of AQUA to create awareness of Quaternary science, and AQUA, to ensure our future. The first round of prizes will be awarded in early 1998 and we hope for a healthy number of applications, and maybe all applicants will feel interested enough to come to Fraser Island in September anyway and find out if they really should have got it after all.

Yours Quaternarily

Paul Hesse

Paul and others at the ANH Dismemberment Event November 28th in Canberra

Forthcoming conferences & meetings

AQUA

Biennial Conference

28 September - 2 October 1998

Fraser Island, Queensland

For details see the circular included with this issue or contact Paul Hesse
School of Earth sciences, Macquarie University, Sydney, NSW 2109
phesse@laurel.ocs.mq.edu.au

General events

5-6 February 1998
IAG Postgraduate Forum, Macquarie University, Sydney, Australia.
Contact: Scott Sharpe
Dept. of Human Geography, School of Earth Sciences, Macquarie University, North Ryde 2109, NSW, Australia
Ph: (02) 9850 8389
email:ssharpe@atlas.es.mq.edu.au

19-23 April
IGBP PAGES Open Science Meeting "Past Global Changes and their Significance for the Future",
Royal Holloway University, London
Contact: Frank Oldfield
IGBP PAGES International Project Office
Bärenplatz 2, CH-3011, Bern, Switzerland
Ph: +41 31 312 3133
email: pages@ubeclu.unibe.ch
Website: http://www.pages.unibe.ch/pages.html

29 June- 3 July 1998
IGBP PAGES PEP II Symposium to be held in conjunction with the IAG Geodiversity conference, University of Notre Dame, Fremantle, Australia
Contact: Prof John Dodson
Dept. Geography, University of Western Australia, Nedlands, WA 6907
Ph: (08) 9380 2697
email: johnd@gis.uwa.edu.au

29 June - 3 July 1998
IAG Geodiversity Conference
University of Notre Dame, Fremantle, Australia.
Contact: A/Prof Roy Jones
School of Social Sciences and Asian Languages
Curtin University of Technology
GPO U 1987, Perth WA 6845
Phone: (08) 9266 7094
email: r_jones@spectrum.curtin.edu.au

5-7 September 1998
The 15th Biennial AMQUA Meeting, Puerto Vallarta, Mexico
Contact: Dr. Eric C. Grimm
Illinois State Museum
Research and Collections Center
Springfield, IL 62703 USA
Ph: 217-785-4846
email: grimm@museum.state.il.us
or visit the AMQUA website
http://www.usu.edu/~amqua/>

3-11 August 1999
INQUA, XV International Congress, "The Environmental Background to Hominid Evolution in Africa", Durban, South Africa
Contact: Conference Secretariat
Conference Africa
PO Box 1722
Parklands, 2121
Johannesburg, South Africa
Ph: +27-11-447-8143
email: cafrica@iafrica.com

Archaeology

April 6-10 1998
The 3rd International Symposium 14C and Archaeology, Lyon, France
Contact: Secretariat (14C and Archaeology Symposium)
Centre de Datation par le RadioCarbone - Batiment 217, 43, Bld du 11 Novembre 1918
69622 Villeurbanne Cedex, France.

email: cdrc14@cismsun.univ-lyon1.fr

April 14-18 1998
Geoscience 98 "Geoarchaeology: exploration, environments, resources"
Contact: Prof. A. M. Pollard
Department of Archaeological Sciences
University of Bradford, Bradford BD7 1DP, UK
Ph: +(0)1274 383530
email: A.M.POLLARD@bradford.ac.uk

10-14 January 1999
The 4th Meeting of the World Archaeology Congress, Cape Town, South Africa
Contact: Congress Secretariat
P.O. Box 44503, Claremont, 7735, South Africa
Ph: +27 (21) 762-8600
email: wac4@globalconf.co.za

Climate change
13-17 April 1998
International Symposium on Climate Variability: Impacts on Rural Activities, Salamander Bay, NSW
Contact: A/Prof Howard A. Bridgman
Department of Geography
University of Newcastle
NSW 2308, Australia
Ph: (02) 9215093
email: gghab@cc.newcastle.edu.au

18-21 May 1998
UNESCO Conference: "Learning from the Past: Global Paleoclimatic Changes" , Yarmouk University, Irbid, Jordan
Contact: Prof. Ali Jawad Ali
UNESCO Chair for Desert Studies and Desertification Control, Faculty of Science, Yarmouk University, Irbid,Jordan
FAX: +962-2-247983
email: ajawad@yucc.yu.edu.jo

Geochronology
20-26 August 1998
The 9th International Conference on Geochronology, Cosmochronology and Isotope Geology (ICOG-9), Beijing, China
Contact: ICOG-9 Secretariat
Chinese Academy of Geological Sciences,
Baiwanzhuang Road 26,Beijing 100037, China
Ph:0086-10-68311545,
email:liudunyi@public.bta.net.cn

Geomorphology
13-17 September 1999
The 8th International Symposium on the Interactions between Sediments and Water, Beijing, China
Contact: Prof. Jingsheng CHEN
Department of Urban and Environmental Sciences
Peking University, Beijing, China
jsc@urbanms.urban.pku.edu.cn

20-28 September 1999
International Geographical Union Commission on Land Degradation and Desertification Meeting, Perth, WA,
Contact: A/Prof Arthur Conacher
Dept of Geography
University of Western Australia
Nedlands, WA 6907
Ph: 61 (0)8 9380 2705
email: ajconach@gis.uwa.edu.au

25-28 September 1998
INQUA Geospatial Analysis of Glaciated Environments (GAGE), Warsaw, Poland,
Contact: Dr. Andrzej Ber
Dept. of Quaternary Geology, Polish Geological Institute, 4 Rakowiecka, Warszawa, 00-975, Poland. Phone: 48-22-495351
email: aber@pgi.waw.pl

Micro and Macro Fossils
9-10 February 1998
Phytolith Workshop, School of Earth Sciences, Macquarie University, Sydney. Abstracts and Registration due by 24 January 1998.
Contact: Dr Diane Hart
Ph: (02) 9869 2300.
email: dhart@magna.com.au,
http://physgeog.es.mq.edu.au/physgeog/workshop5

9-12 February 1998
Second Workshop on Global Paleoenvironmental Data, Boulder, Colorado, U.S.A.
Contact: Robin Webb or Dave Anderson
Ph: +1 303 497-6160
email: danderson@ngdc.noaa.gov, rwebb@ngdc.noaa.gov

10-13 February 1998
The 7th International Nannoplankton Association (INA) Conference, La Parguera, Puerto Rico
Contact: Amos Winter (Convenor)
Ph: (787) 265-5416
email: INA7@rumax.upr.clu.edu
Website: http://wwei.ucsd.edu/INA7.htm

Quaternary Diary

15-18 April 1998
Vertebrate Palaeontology Student Conference, Naracoorte, South Australia
Contact: Liz Reed and Matt McDowell
Flinders University, South Australia.
Email addresses:
liz.reed@flinders.edu.au
matthew.mcdowell@flinders.edu.au

24-26 June 1998
7th International Conodont Symposium (ECOS VII), Bologna and Modena, Italy
Contact: M. C. Perri
Dipartimento di Scienze della Terra e Geologico Ambientali, via Zamboni 67, 40126 Bologna, Italy
Ph: 39-51- 354560
FAX: 39-51-354522
email: perri@geomin.unibo.it

6-9 July 1998
Pollen and Spores: Morphology and Biology, London, UK
Contact: Lisa von Schlippe
Conference Administrator
Royal Botanic Gardens, Kew, Richmond, SURREY, TW9 3AB, UK
Ph: +44 (0) 181 332 5198
email: l.von.schlippe@rbgkew.org.uk

6-10 July 1998
Mary Wade Palaeontological Symposium (part of the 14th Australian Geological Symposium), Townsville, Queensland, Australia
Contact: Dr Alex Cook
Queensland Museum
PO Box 3300, South Brisbane Queensland, 4101
email: a.cook@mailbox.uq.oz.au

7-11 July 1998
FORAMS '98, Monterrey, Mexico
Contact: Martha A. Gamper
email: gamperma@fiu.edu
Website
http://www.fiu.edu/~longoria/forams98.htm

27-29 August 1998
The 2nd International Meeting on Phytolith Research, Aix en Provence, France
Contact: J.D. Meunier
CEREGE, Europole, Mediterraneen de l'Arbois, BP 80, 13545 Aix en Provence Cedex 4, FRANCE
Ph: (33) (0) 442971526
email : phytomeeting@cerege.fr

Oceanography
23-28 August 1998
The 6th International Conference on Palaeoceanography "Reconstructing Ocean History, a window into the future", Lisbon, Portugal
Contact: Fatima Abrantes
email: ovaia@abreu.mailpac.pt

Stable Isotopes
20-22 April 1998
Applications of Stable Isotope Techniques to Ecological Studies, Saskatoon, Saskatchewan, Canada
Contact: Dr. Keith Hobson
Canadian Wildlife Service
115 Perimeter Road
Saskatoon, SK
Canada, S7N 0X4
Ph: (306) 975-4102
email: Keith.Hobson@EC.GC.CA

Lake Eyre
AQUA Biennial Meeting 1997

By Geoff Hunt

Div. of Archaeology & Natural History
Research School of Pacific & Asian Studies
Australian National University
Canberra ACT 0200

Geoff Hunt exploring Lake Clayton (Photo by K.Harle)

The biennial meeting was held on the 22-28th April in the environs of Lake Eyre. This ended a period of some confusion given that the first notices were for an October 1996 meeting down Apollo Bay way. About 50 people attended with the majority coming from Canberra and Melbourne and it was good to have a large turn out of students. A very successful meeting, it served to highlight the tremendous advances made in the region in the last decade.

What a glorious spot to hold the AQUA conference! To those of you who didn't attend - you missed out on one of the most enjoyable conference locations imaginable. Here we were on Muloorina Station, three-quarters of an hour's drive from Marree - that metropolis of 84 souls which is the last town of the string that runs up the western side of the Northern Flinders Ranges. Accommodation at the station was either in the shearers' quarters or camped down beside a bore-fed lagoon in the shade of the coolabah trees. The large lagoon provided opportunity for cooling swims and attracted a wide diversity of native bird species. The lagoon lies in the bed of Frome Ck which is sourced in the Flinders Ranges and flows (occasionally) north into Lake Clayton. Two canegrass covered linear dunes terminate on the western side of the north-south channel near the camp. The weather was ideal - cool nights followed by warm to hot sunny days with breezes building up during the morning and fading at dusk. Comet Hale-Bopp and the full moon provided after-dark visual effects.

As the accompanying map shows (figure 1), Muloorina homestead sits in a convenient position for exploring the Quaternary history of Lake Eyre. A transect from the southeast corner of figure 1 northwest towards the lake crosses a series of beach ridges which are progressively both younger and lower in altitude. Between ridges are stretches of old lake floor. Stratigraphic exposures are restricted to the bluffs surrounding the current playas and old shorelines further inland. A second map (figure 2) covers the area west of Williams Point, including the Hunt Peninsula and Jackboot Bay. This was the scene for one of the post-conference field trips described below.

Tuesday

The meeting was planned so that conference sessions and field trips were interspersed. An introductory afternoon field trip was led by John Magee for those who arrived early to the meeting. This first excursion showed just how low the relief was with a visit to a beach ridge (Morley Dam) which appeared to barely rise above the surrounding plain. It has a gibber surface which included rounded quartz crystals and ironstone pebbles. This was part of the undated, but probably Stage 9 or older, 25 m AHD shoreline. A second beach ridge (Bully Sand Hill) with a capping of dune sand gave an opportunity to collect emu and *Genyornis* eggshell eroding out of the dune sands. These fragments have assumed great significance in the determination of the palaeo-environmental history following research initiated by Gifford Miller of the University of Colorado. Amino acid racemisation and

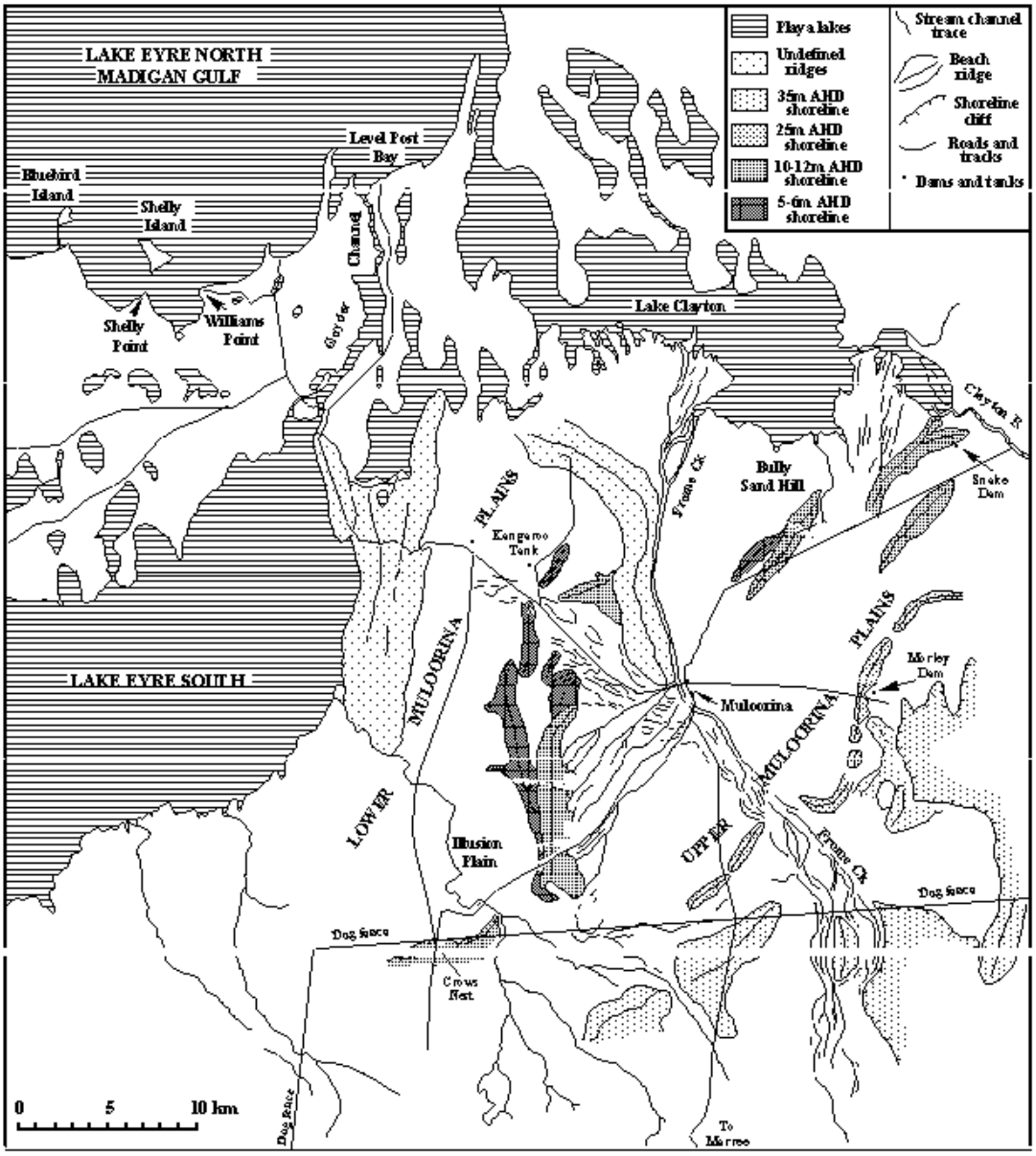

Figure 1: *Simplified geomorphological map of the Muloorina area showing roads and sites (modified from Magee, unpublished PhD thesis)*

isotope compositions are used to provide chronologies and information about past temperature, effective moisture, and vegetation type. This ridge formed the 10-12 m AHD shoreline of early Stage 5 while the capping dune has been dated to 90 ka. From there we descended to Lake Clayton - the first close up of a salt crusted playa lake. Here were shore cliff exposures of the Miocene Etadunna Formation. That evening, after a tasty barbeque, John Magee gave a talk on the Lake Eyre Basin. He provided a picture of an area which has undergone shifting conditions ranging from wetter phases, when the lake was full, to dry phases (drier than today) when dunes formed and deflation of the lake floor occurred. Moisture is derived predominantly from the northern part of the catchment and relates to the monsoon. Thus a record of the lake full and dry events provides a proxy for the strength of the palaeo-

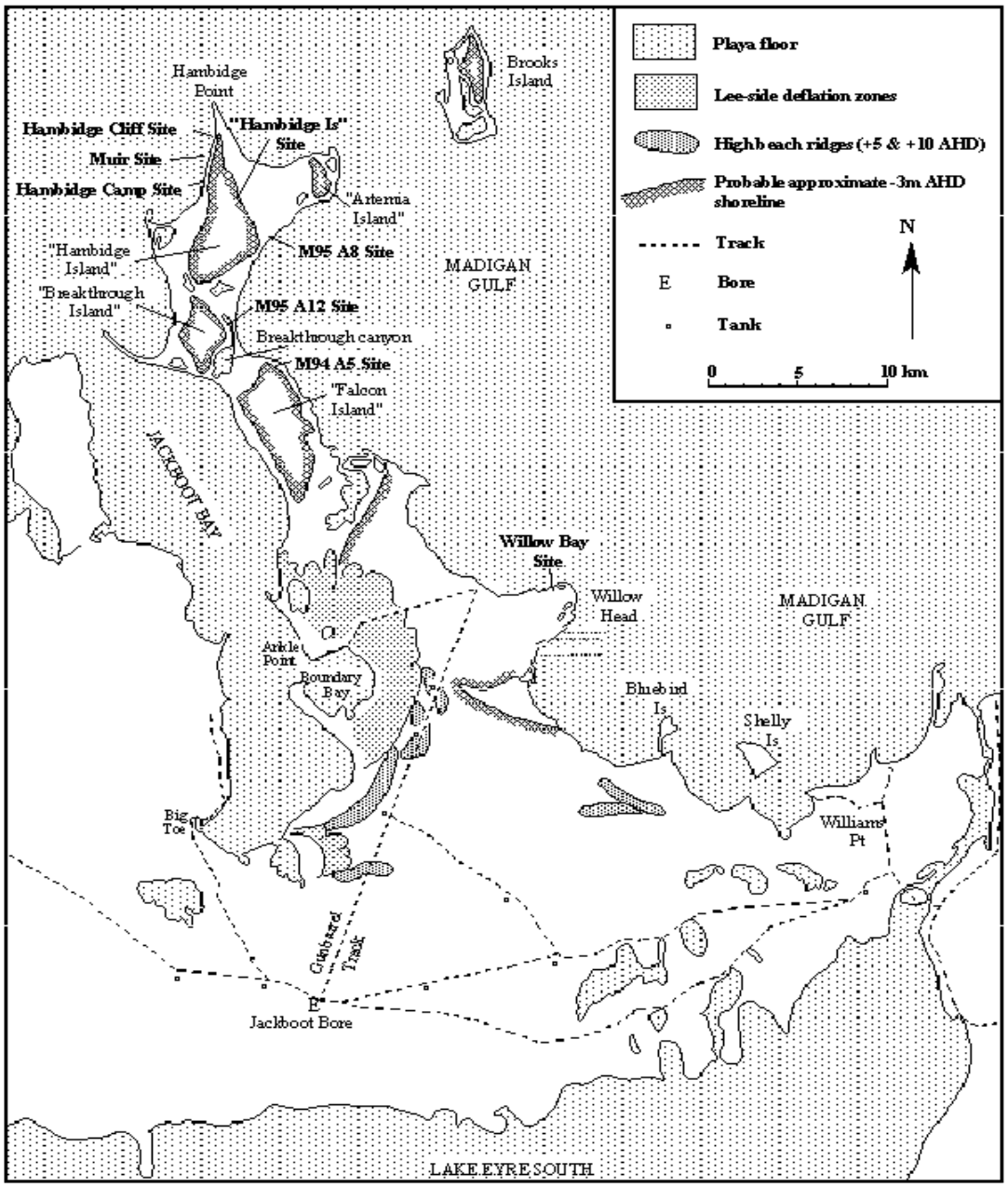

Figure 2: *Simplified geomorphological map of the Hunt Peninsula showing tracks and sites (modified from Magee, unpublished PhD thesis)*

monsoon. A fairly well-constrained 130 ka history of lake conditions indicates the Holocene is notably drier than the last interglacial. Magee et al. (1995) provides an excellent description of the stratigraphy and palaeoenvironmental interpretation for Madigan Gulf.

Wednesday

The opening session of the conference concentrated on work in the arid zone. John Jansen described the episodic nature of extreme flood events in the Barrier Ranges and how these would obscure any record of regional climatic changes.

Linda Ayliffe documented the efforts in TIMS U-series dating of *Genyornis* eggshell, showing that in most cases the ages match reasonably well with other techniques. Beverley Johnson gave a rapid run-down on how emu and *Genyornis* eggshell isotopic composition provided a

The Wednesday paper session inside the shearers' mess hall (Photo by K. Harle)

Fossicking in rabbit holes for shells (Photo by K. Harle)

record of climate and vegetation change for the last 70 ka. Julian Reid gave a wide reaching talk on the ecology of the region and the questions that faunal/floral distributions raised about the nature of the landscape and its history. The modern ecology provides an under-utilised window in understanding past environments.

The next session dealt with database and modelling issues. Geoff Hope described the latest state of progress on the INDOPAC pollen database and what was available via the Internet. Tim Barrows provided details on where QUATDB ended up and indicated the future path of data storage in the Australian Quaternary Data Archive up and running on the Internet. Kate Harle put forward preliminary results, for southeastern Australia, of a biome modelling program (based on pollen data) which incorporates significant but small percentage abundance taxa. Lynette Peterson, by reference to misinterpreted mining waste deposits in the Bendigo region, proposed that historical records are essential for understanding the geomorphic history of regions affected by human activity.

Lunch was a help yourself to sandwich ingredients and then head for the nearest patch of shade with a breeze. The afternoon sessions were allotted to student presentations of work in progress. A variable set of sometimes reluctant presentations depending on the degree of prior knowledge of the event and the quantity of research already undertaken. Research topics were mostly of a geomorphological or palynological bent. Then it was time for a swim in the lagoon to freshen up for dinner with a pasta theme.

Thursday

On the second field trip a convoy of ten white vehicles was strung out across the plains in a plume of dust. A far cry from the days when Muloorina had camel trains led by Afghans. Two more beach ridge sites were visited. The first, southwest of the camp on the Illusion Plain, was actually two ridges; the early Stage 5, 10-12 m AHD shoreline and an inner, late Stage 5, 5-6 m AHD shoreline. These ridges and the source bordering dune behind them form the source material for the linear dunes terminating on Frome Creek. Then north-westwards from the station for a stop on part of the old lake floor. Again we observed how deceptive this landscape is to the human eye. Two kilometres or so westward was a continuation of the 5-6 m AHD ridge (Kangaroo Tank) which looked more like a higher ridge much further distant. Moving onto this ridge we examined a rabbit warren for recently excavated material (rabbits form a useful random auguring system for material within the upper metre or so). Excavated material included eggshell, *Corbiculina* and *Coxiellada* shells.

Shells extracted from a rabbit warren (Photo by K.Harle)

From there we continued northwestwards to our first glimpse of Lake Eyre South, a white emptiness stretching away into the distance. After crossing Goyder Channel (linking Lake Eyre North and South) it was out to Williams Point overlooking Madigan Gulf. At Williams Point (named after the late Dominic Williams a former researcher in the Lake Eyre region) we saw the key section extending back to the basal Etadunna Formation. John Magee described the components of the section (see Magee et al., 1995 for a full description). The lower, finely laminated clays were deposited in a salinity stratified lake, undated but thought to be older than 100 ka.

John Magee explaining the Williams Point Stratigraphy (Photo by K.Harle)

They probably form the lacustrine equivalent of the 10-12 m AHD shoreline beyond the current margin of the lake. Above a surface rep-resenting an exposed mudflat there is a second set of lacustrine deposits. These deposits are of a shallower lake with ages ranging from 90 ka at the base to 80 ka in the upper unit. Following an erosional break a coquina of *Coxiellada* shells was deposited, forming the last unit related to lacustrine conditions in the section. This coquina has ages ranging from 70 to 60 ka. Above this unit is dune sand to the top of the section with ages from 65 to 30 ka. This dune sand represents the drying phase of the lake; an episode of major deflation and accompanying aeolian deposition as the groundwater table fell. Deflation and aeolian deposition was not as significant at the glacial maximum due to the already low level of the groundwater table. The rest of the day was occupied with searching for eggshell and other fossil material, wandering out onto the salt crust and exploring the area.

The after-dinner speaker was Michael Cathcart who gave a talk entitled 'The Great Inland Sea'. He examined the human perspectives/ perceptions on the arid landscape by looking at the use of particular phraseology such as 'the dead heart' and 'the silence' of the desert.

Friday

On the morning of the second day of presentations, Mark the pilot of the Marree based scenic flight tours took several plane loads up for 40 minute flights out over the landscape. This visually stunning opportunity gave another perspective to the area allowing you to trace the course of dunes and beach ridges and also to see the pink water (due to *Dunaliella* algae) in Jackboot Bay. The linear patterns of human occupation (vehicle tracks, fences, seismic lines) form a notable component of the landscape even in such a sparsely populated area as this. The sheer expanse of Lake Eyre gave some idea of the scale of processes involved and the enormity of any project aimed at understanding its history.

Meanwhile the morning session started late and Bernie Joyce opened proceedings with a description of Quaternary activities underway at Melbourne University. Xiu Ming Liu followed with further thermomagnetic results from the Chinese loess deposits including a high resolution climate record using magnetic susceptibility. Lynda Taylor reported on a complex and diverse set of lakes in the Wimmera which she is analysing utilising the ostracod fauna as recorders of hydrological conditions. John Barrie talked of the palaeontological excavation of Henschke's Cave.

Linda Ayliffe described a 500 ka

record of effective-precipitation derived from Naracoorte speleothems with carbonate deposition switching off in dry periods. Paul Hesse aired some views about the correct use of marine isotope stage chronology. Brad Pillans identified a change in weathering regimes around 400-500 ka (estimated from magneto-stratigraphy) at sites in SE South Australia and Kangaroo Is implying an increase in aridity. Jim Peterson used a glacio-climatic approach to argue that Lake Ooze (Southern Range, Tasmania) was a marginal location for glaciation, would have deglaciated earlier than other cirques in the range and hence has the potential of providing the longest post-glacial record. That formed the end of the formal proceedings with Rob Ferguson and Tim Barrows finishing up with talks on their respective PhD projects.

After a short break to recover from the heat of the room and prepare for the evening it was time to organise the conference dinner and conduct the Biennial General Meeting. Thanks and gifts were duly bestowed on those who had been responsible for making the trip such a well run one. Student prizes went to Lynda Taylor (PhD) and Kate Warren (Hons) both of the Geology Dept, ANU for their presentations. Following re-election of Geoff Hope as Membership Secretary and Christine Kenyon as Treasurer, Paul Hesse was voted in as the new President and Damian Gore as Secretary giving a distinctly Macquarie Uni focus to the new Committee. Kate Harle volunteered to take on the role of Editor of the QA magazine with Bill Boyd taking a well-earned break after an eight year stint [*I think alcohol consumption had something to do with my acceptance* - eds note]. Then it was dinner time with a barbeque catering for both omnivores and herbivores. We (including the Mitchell families) sat out at trestle tables with the moon rising and a couple of 20 litre casks of wine. After a dessert of trifle and melon with fresh ginger it was inside to watch a video of historic footage of Muloorina Station at the time of Campbell's attempt at the land-speed record on Madigan Gulf. Rhys Jones ended the evening with a talk on Australian archaeology and the new dating techniques which have made it possible to push back the date of earliest arrival beyond the once intractable radiocarbon limit. Given the timing of his talk the audience was perhaps a trifle less attentive than usual.

Saturday and beyond

Following the 'formal' part of the meeting two excursions were held. One, led by John Magee went up the Hunt Peninsula, west of Madigan Gulf (see map). It was a surprise to be informed that the apparently flat surface of the Gunbarrel Road on Hunt Peninsula was an incline with a fall of 15 m in 10 km and crossed two beach ridges (10-12 m AHD and 5-6 m AHD). First camp was tucked below the source bordering dune at Ankle Point. That evening, sunset was a bright saffron yellow, reflected off the still water in Jackboot Bay and as the light faded the comet appeared. Hard to find complaint in a trip with camp-oven roasts for dinner under a canopy of stars and a waning but near full moon. A good section is preserved in the shore cliff round Ankle Point; a basal clean grey fine sand (presumed Etadunna Formation) with overlying cross-bedded dune sands (Williams Point aeolian unit). On the surface of the point, tree roots and old stumps rear up, their original composition replaced by gypsum. A large quantity of eggshell was also present and we sampled from the erosion surface up into the younger Shelly Island unit overlying the Williams Point unit. A short drive further north allowed access to another shore exposure. Here gypsified Williams Point aeolian material had been deflated, gullied and eroded in a karst-like manner and subsequently the gullies infilled by the Shelly Point unit. The party then travelled back to the base of Hunt Peninsula and westward to reach camp above the southwest corner of Jackboot Bay. At the Big Toe section the upper erosional surface contained quite a number of tektites and eggshell fragments. Again the stratigraphy recorded episodes of lacustrine deposition, erosion and aeolian deposition. From this site it was back to Muloorina before heading home.

The second trip was led by Geoff Hope and involved substantially more travelling. On the first afternoon some mound springs were visited to the west of Lake Eyre before camping out

Mound Springs near the Etadunna track *(Photo by K.Harle)*

at the old Stuart Creek Homestead. Mound springs like these are threatened by the unmanaged human use of the artesian water which forms them. Capping of uncontrolled bores and regulation of water use are needed given an extremely slow renewal rate. The next day Tertiary plant fossils were found at Stephen's Ck and a trip made to the Lake Torrens playa. From there it was the long haul back to the eastern states.

Many thanks should be given to the efforts of the organisers. John Magee, the on-site expert, structured the scientific component of the meeting and field excursions to highlight the geomorphology, stratigraphy and palaeo-environmental history of the region. He also produced field guides for the Lake Eyre excursions. Geoff Hope as AQUA membership secretary organised the flyers and tallied the attendees. In this he was assisted and organised by Gillian Atkin and Dominique O'Dea who were also involved in the planning and acquiring of enough food stuffs to feed the mob. If that was not enough they then attended the meeting as chief caterers to ensure things ran smoothly. Ian Thomas and Christine Kenyon organised the Melbourne end and produced the abstract volume. Last but not least we should all again give thanks to the Mitchells (Malcolm, Trevor and their families) for putting up with us all on their property.

Out at Williams Point the salt crust has receded. The negotiable route is now a well beaten path. A cow's skull wired to a star picket, a few patches of charcoal, some small piles of rock and a few diggings into the side of the cliff are the only signs of recent human activity. The sun is still bright and gusts of wind blow strongly up the section. The resident goanna emerges from his burrow beside the Temporary Bench Mark in search of food.

The next AQUA field trip will be held at Fraser Island in the latter half of 1998...

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Dominique discovers the joys of outdoor camping on Geoff Hope's post Aqua field trip (Photo by K. Harle)

A full catalogue of colour photos taken by Kate Harle on the 1997 AQUA field trip is available if you wish to order reprints. The estimated cost is $1 for a standard photo sized reprint (although this could be cheaper if bulk reprint orders are made to the local photographic store). Kate's address is on the inside cover of this issue.

Marine Geology '97
The 3rd COGS Conference

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The Marine Geology '97 meeting was successfully held during 30 September- 3 October 1997 at the Department of Geology & Geophysics, University of Adelaide in the Mawson lecture theatre. The conference was aimed at maintaining internal cohesion among Australia's small and fragmented marine geoscience community and providing a forum for the discussion of issues affecting the community.

A total of about 45 people attended, providing a very high-quality succession of papers and posters (40+ in toto). The talk sessions were divided into themes, with a healthy representation by marine and coastal Quaternarists, which are summarised here. On the first day, Patrick DeDeckker, Ignacio Martinez and Tim Barrows presented new results obtained from a large number of cores and water samples taken using the *Franklin* in the eastern Indian Ocean. This dataset is providing new understanding of the dynamics of the 'Warm Pool' through the study of planktonic foraminifera and badly needed geochemical data for the region. A session on offshore Quaternary sediments followed, led by Ron Boyd. Ron and colleagues have provided a sedimentological history for a section of the central NSW coast showing changing styles of sedimentation with sea-level change during the last 2 glacial cycles.

The following day opened with a talk by Brad Opdyke who presented data from cores taken on the Scott Plateau, in the north-eastern Indian Ocean. These cores show dramatic changes in silica productivity and aeolian dust-flux in the region during the last 100 ka. Peter Harris then reviewed the Antarctic Marine Geology Program's new results in the Vincennes Bay, Prydz Bay and Robertson shelf area. This work is mainly documenting fluctuations in ice-sheet volume during the last glacial maximum and subsequent deglaciation. Peter Sedgwick followed with more Antarctic data from a geochemical study conducted on the continental shelf off Mac. Robertson Land. This pioneering work is providing a new perspective on shelf productivity. Tim Barrows concluded the Quaternary talks for day 2 with a new reconstruction of the SE Australian margin during the last glacial maximum. This new interpretation shows large deviations from present in sea-surface temperature and changes in oceanography triggered by changing wind-fields. Tim also won the prize for the best student paper and Louise Christian presented the best poster.

The final day saw several more Quaternary talks. Alan Brenchley presented new cores taken from shallow coastal lakes in the Robe-Woakwine corridor of SE South Australia. The record of Holocene transgression preserved here shows an actively evolving coastal margin. A detailed account of sediment storage and fluvio-deltaic evolution in river valleys of northern NSW followed was then given by Takehiko Hashimoto. These valleys have slowly been infilling during the Holocene transgression. After lunch, Lindsay Collins spoke about the evolution of the Houtman Abrolhos coral reef complex in the Indian Ocean. Recent coring has demonstrated that these carbonate platforms have actively evolved from the Tertiary into the Quaternary. The final Quaternary talk was given by Ron Boyd on the Quaternary stratigraphy of the

Hunter Valley. A detailed coring and dating program is revealing a complex history for the basin.

An Ocean Drilling Program Scientific Committee meeting was also held and some progress was made on commonality in data bases and marine equipment. The excursion, from Maslin Bay to The Barn at MacLaren Vale via a couple of viticultural tests of the North Maslin and Blanche Point substrates, went well.

Thanks are to be extended to the organising committee who provided a well co-ordinated, smooth-running conference: Brian McGowran with Yvonne Bone, Qianyu Li, Liz Campbell, Vic Gostin, Miles Davies, Rolf Schmidt, John Cann, with some assistance from Chris von der Borch. Special thanks to Miles and Rolf, who did much of the grunt work with initiative and good cheer as well as putting in plenty of ideas. Thanks must also be extended to the departmental Manager Gerald Buttfield, who can add scrounging and hoarding to his already impressive list of qualifications. The Abstracts (Bone & Campbell) and Field Guide (McGowran & Li) are available at cost.

The meeting was sponsored by COGS and the Department of Geology & Geophysics, The University of Adelaide. Lindsay Collins (Curtin) has undertaken to hold Marine Geology '99 in Perth.

CLIP 1997

In the absence of a report on the 1997 UNESCO CLIP (Climates of the Past) and CLIMEX (Climate Mapping of Extremes of the Last Glacial Cycle) meeting held in Townsville, Queensland from the 27th of September to the 4th of October here is a photo of one of the participants on her way home. Don't say I didn't warn you Naomi!

Lake district of Chile and adjacent Argentina

Reflections on the Southern Connection Post-Congress Field Excursion

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Tree lines (Araucaria), glaciers and scoria.

Whilst `drying out' on the long and disjointed journey back to Australia, I am looking back on what turned out to be, somewhat surprisingly, a major lifetime experience. In my ignorance of the region, I had visions of six days wandering through wet, misty, and monotonous forests, a perspective reinforced to some degree by the one-day excursion to Puyehue National Park, Chile, the frequently inclement weather in Valdivia, and especially by the heavy rain which heralded the beginning of the trip. Certainly the area, between about 38 and 42 degrees south, is categorised in the field guide as `rainy and wet' although it becomes more mediterranean to the north.

The excursion traversed the major physiographic regions of the area - the ancient and highly disturbed Coastal Cordillera, the `wide' Central Depression which supports mainly agricultural or abandoned agricultural land, and the Andean Cordillera characterised by glacial and volcanic features. As expected, the excursion focused on the latter region and in particular on Nahuelhuopi National Park in Argentina, contiguous with Puyehue National Park on the Chile side of the border, Alerce Andino National Park adjacent to the Island of Chiloe in the south which supports magnificent stands of *Fitzroya cupressoides* (alerce) forest, and Conguillio National Park in the north *featuring Araucaria araucana*. All individuals of both *Fitzroya* and *Araucaria* are protected as National Monuments.

Each of the days provided distinctive characteristics which were neatly captured by Peter Johnson in his thankyou address to the excursion leaders at the end of the trip.

Much of the first day (rain day) was spent in flight towards drier Argentina, punctuated by substantial holdups at the Chilean and Argentinian border posts. Once in Argentina the rain did contract to showers which were useful to Tom Veblin in helping to exercise some control over the length of stops. There was a tendency for the group to scatter immediately in search of insects, rare plants etc. Some members, though, stayed to hear about the distribution and dynamics of the vegetation as it changed along the decreasing rainfall

gradient from *Nothofagus dombeyi* forests, through *Nothofagus dombeyi/ Austrocedrus chilensis* forests and *Austrocedrus chilensis* forests and woodlands to shrublands dominated by a mix of taxa including *Lomatia hirsuta, Nothofagus antarctica, Diostea juncea, Schinus patagonicus, Maytenus boaria* and *Berbis buxifolia*, and steppe characterised by bunch grasses (e.g. *Stipa* and *Festuca*), other herbaceous plants such as *Acaena* and *Senecio* species, and shrubs *including Mulinum spinossum, Discaria articulata, Berris sp*p. and *Fabiana imbricata.* This striking vegetation gradient was of special interest to Australians and New Zealanders who experience only sharp boundaries or limited transitions between rainforest and drier sclerophyll or grassland communities respectively. Time was also conserved by the improbability of the bus reaching some planned stops without wallowing in the mud like the Piggly Wiggly truck we passed.

On the Monday (sun day) we were able to examine the steppe-forest transition in a more leisurely fashion and good views of the snow-capped Andes on the return to Chile were possible under the drier conditions. With the absence of Tom Veblin, we converted to `Lara' time which resulted in darkness descending before we had the opportunity to visit a remnant *Fitzroya* stand in the Central depression. The destruction of *Fitzroya* forests in the region is one of the fastest recorded in South America and attributed to German colonisation in 1860. The remnant stand appears, from dendrochronological and fire scar studies, to have re-established following a devastating fire shortly before 1875. The flat and swampy landscape going into Puerto Montt, the ultimate destination of the day, still retained evidence of the destroyed *Fitzroya* trees within abandoned agricultural land reminiscent of New Zealand's pakahi. Of course it was also too late to visit a fossil forest, dated to about 45,000 BP, exposed in the tidal zone near Punta Montt and which is also the subject of dendro-chronological study.

The third day (mud day) was the most challenging and saw the introduction of the Antonio combined with Lara time, unaccounted bus speed - or lack of it, and steady morning rain, ensured the impossibility of completing the obstacle course planned for Alerce Andino National Park. Problems were encountered by those with inappropriate centres of gravity or footwear. However, almost everyone, with the noted exception of Barry Fox who decided to dislocate his shoulder, surprisingly managed to reach stop 2 (out of the planned 5 or 6). Here we were treated to a magnificent old growth stand of *Fitzroya* which, from the studies of Antonio Lara, has an even-aged structure and probably regen-erated after a major landslide about 800 years ago. Older stands, with ages in excess of 2000 years, remained uncon-quered by most of the group. Excellent views of the predominant *Nothofagus nitida/ Saxegothaea/Laureliopsis/ Eucryphia* mixed broadleaved or Valdivian forest and recent landslides were obtained from the picturesque Lago Sargazo. The poor state of the track, with creeks forming along much of it, highlighted the lack of support received for mainten-ance of the National Park system. A second attempt to visit the fossil *Fitzroya* forest was thwarted by the decision of workmen to dig up the road in front of us and substantially delay our return to Punta Montt.

`Bus day' began with the abandonment of a third attempt to visit the fossil forest, this time due to a high tide, and much of the day was spent travelling north to Temuco. Here we visited a small forest reserve, classified as a Natural Monument, which is transitional between the northern mediter-ranean `sclerophyll' and southern cool temperate rainforest floras. The old-growth mixed broadleaved forest is dominated by *Nothofagus obliqua, Persea ligue, Aextoxicon punctatum* and *Cryptocarya alba*, with the latter, in particular, having very sclerophyllous leaves. The forest also contains yet another species of *Nothofagus,* the inaptly named *N. alpina*, which is characterised by its large leaves. We then proceeded to Conguillio National Park, traversing recent lava flows of Volcan Llaima until the bus refused to travel further. Most of the final 10 kilometres (or 4 Antonios) were completed on foot and a true `lost world' feeling was generated in the fading light as ancient araucarias, silhouetted against the mountains and sky, came to dominate the landscape.

The full beauty of the Park was revealed on `Ash

Thursday'. The excesses of the previous evening were forgotten as we witnessed the early morning sun shining on the serene, yet apparently somewhat eutrophic, Laguna Conguillio and surrounding snow and glacier capped volcanic peaks. The scene was progressively enhanced as we climbed the Sierra Nevada through various *Nothofagus* - dominated forests eventually reaching *the N. pumilio* treeline. At this altitude the majestic *Araucaria araucana* trees were back in force and appeared contemp-tuous of generally accepted limits for tree growth. Its a pity that Peter Wardle was not with us to provide some explanation for this phenomenon. I think some comment by him in the newsletter would be very welcome. The magnificent views from this altitude of smoking V. Lliama and its lava flows, more distant volcanic peaks, lava-dammed lakes and the cirques and glaciers of Sierra Nevada, all seen through the weird branches of *A. araucana*, would be difficult to match elsewhere in the world.

The final `winding-down day' featured forest management though we were not spared a climb to the top of a small mountain. Despite 30% of Chile being still covered in native forest, more than 80% of industrial production comes from forest plantations, mainly composed of *Pinus radiata* and Eucalyptus spp. We visited one attempt to manage secondary native forest for sustainable wood production. This was being trialed by a timber company apparently without any support from a dis-interested government.

Overall, this extremely well planned and documented field trip clearly reflected the title of the Congress `Southern Temperate Biota and Eco-systems: Past, Present and Future' although the title of the trip itself disguised its scope and significance. The major theme was the dynamic nature of the landscape and how glaciation, tectonics, vulcanicity, landslides and fire, at different scales of operation, have influenced the composition, history and successional relationships of the vegetation. I was amazed by the variety of strategies adopted by *Nothofagus* species to survive and dominate in a range of environments. This diversity, combined with the actual environmental spread of the genus, provides much food for thought concerning the interpretation of Australian Tertiary assemblages. I was also impressed by the distrib-ution patterns of other taxa which had so many parallels with the same or similar taxa in Australia and they certainly help to place past and present Gondwanan connections into clearer perspective. Equally impressive is the amount and nature of research being undertaken by the excursion leaders and others on the dynamics of the vegetation, particularly through the use of dendrochronology and fire scar studies. I would have liked to have seen more emphasis placed on palynological studies to provide a picture of longer term dynamics. However, to satisfy the specific interests of everyone would have required a separate bus load of specialists. One unexpected feature of the Chilean forests was the almost ubiquitous presence, and frequent dominance, of *Chusquea* bamboos in the understorey of the forests and the influence that these can have on forest dynamics. It was appropriate that, on the final day, we witnessed the preliminary application of the research on successional dynamics to sustainable forest manage-ment.

In keeping with the theme, the excursion leaders were equally dynamic. Both Antonio Lara and Alexia Wolodarsky sustained amazing levels of enthusiasm and energy through the whole period and made the trip extremely enjoyable as well as informative. We also apprec-iated the input of other people including National Park Rangers and the long suffering driver who shared our frustration that his bus would only achieve speeds of 20 Antonios per Lara.

The dynamics of the group increased through the excursion. Initially, interaction was largely limited to a few words in the queue for the toilet as a number of people had minor stomach ailments, and to comments about chicken lunches. The large choice of restaurants provided also ensured that the group dispersed on reaching evening destinations. By the third evening the group was being brought together and on the fourth evening we had no choice. The preceding 10 km walk had brought back memories to some of old student days and our Chilean hosts were subjected to a succession of increasingly more bawdy rugby and bushwalking songs until well into the morning hours. It may be no coincidence that major proponents had graduated from Bangor. The more acceptable, though

probably least appropriate, of these songs ie `Ilkla Moor `baht `at' and `The Wild West Show', were selected for rendition at the unscheduled beer and stew lunch celebration hurriedly arranged by the remarkable Alexia for 6pm on the final day.

The field trip was an undoubted success and such trips should become an integral part of future meetings. At least one trip will be part of the 2000 New Zealand Congress judging from John Ogden's comments and the notes he was taking. The idea of staggering two trips by a day was also a good idea as it ensured that my forgotten jacket was later collected.

We were supplied with a substantial list of recommended readings. A selection of these plus a few pending publications are listed for those who would like to know a bit more about aspects of this report..

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Southern Connection

Southern Connection is an informal group of hundreds of scientists with a mutual interest in the biota of the Southern Hemisphere. The vast distances between land masses in the Southern Hemisphere coupled with language and general communication difficulties have made it difficult for people to exchange information in the past. Southern Connection is dedicated to improving that situation. It was formed in 1993, and since that time there have been two very successful conferences with a third planned for Christchurch in 2000. Southern Connection has a twice yearly bulletin, a web page and an email discussion group. There is no joining fee, although there is a small charge to cover printing and postage if you want to receive a hard copy of the Bulletin. The Bulletin can be received free of charge from the web page (see the link via: http://www.utas.edu.au/docs/plant_science/P.S._Homepage.html**).**

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1997 excursion to Lake Mungo and the Riverine Plain

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Erosional forms at the Palaeomagnetic site, Walls of China, Lake Mungo.

This year saw the passing of an era. Perhaps it seems especially significant to me, for I write this following the weekend's ANH (Archaeology & Natural History) Dismemberment Ball. Around 200 past and present members of the division turned out in assorted finery at Canberra's Albert Hall for a happy occasion marking tragic circumstances. For by the end of the year the division will be no more, "mowed down in its prime: a victim of irrationalism" as the invitation mourned. Academic and technical staff and students from this division have been forced to scramble into disparate schools and faculties - wherever a place could be found. It may be fortunate that most did find a place, but it is not satisfactory. Dismemberment accurately describes what Quaternary research in Australia is experiencing today.

The 12-15th of September was the last time that Jim Bowler and Bernie Joyce were to lead the third year field trip to the Riverine Plain and Lake Mungo, part of the Surficial and Quaternary Geology course (School of Earth Sciences, University of Melbourne). A small mob of PhD students and a research scientist from Canberra were fortunate enough to tag along. The excursion visited some of the key sites used in the fleshing out of a Quaternary palaeoenviron-mental history for the region and in gaining an apprec-iation of the true antiquity of Aboriginal presence. As it turned out the trip also highlighted some of the issues that face researchers and the community in the '90s.

On the way across to Lake Mungo to meet up with the group the Canberrans stopped in at Wagga Wagga to visit the Wagga brick pit. Tony Dare-Edwards was on hand to explain the section and its history. A program of dating using TL, palaeomag and U/Th is clarifying the timescale of the soil stratigraphic units so well exposed in the pit. The oldest (Marinna) unit is now considered to range back to the Late Miocene. By the way - it's probably too late to visit now. The pit being in a convenient inner city location and no longer used as source of material turns a handsome profit as a dump site. By the time we arrived the entire eastern face had been buried and as we stood on the unstable slope of builder's rubble new loads were being dumped over the side of the pit. Before leaving Wagga Wagga we went on to some of the local gully systems, products of prior rabbit infestations. Here TL dating is showing that while similar sets of sedimentary units are repeated across the landscape they are not synchronous, differing in age by tens of thousands of years.

At Lake Mungo campsite the next morning Jim Bowler produced maps, aerial photos and satellite images and spread them over the ground to aid his background description of the region. Jim also produced his ornate dagger with which he is as adept at drawing mud maps on any convenient earth surface, clearing the face of an exposure or indicating significant points. The country was deceptively green with a few weeks of rain following a prolonged drought. After a pause on the western shoreline for a brief inspection it was across to the Walls of China. Here Jim's incredible accumulation of knowledge was abundantly displayed to the group. Slight colour variations or an almost unnoticed trace of gravel were revealed as marking erosional breaks in the sequence or an old

Wagga Brick Pit - what's left of it

beach. The big picture, the fine detail, the environment, issues still un-resolved, work needing to be done; all were explained simply and effectively.

Parts of the lake are now restricted areas and prior permission from the Aboriginal custodians and the presence of an Aboriginal representative are required before visiting them. One of these areas contains the sites of the Mungo burials, topical given that week's ABC Quantum program on the timing of Aboriginal arrival in Australia. However, having arranged things, we were disappointed when the representative did not turn up. In any case, we were privileged when one of the park rangers, James Baldwin, gave a talk. Beginning with a description of the nature and importance of the region it was sobering to hear his account of the troubles being faced both here and at other parks. Issues included lack of funds (allowing only essential maintenance), being 'a political football' (policy related to external influences rather than local needs), the hand over to the Aboriginal custodians (conflict between the three local tribes) and misunderstandings. For example control of pest and certain native species is essential if the native cypress pine woodland on the ridge above the western shoreline is to regenerate. While the recent rains and absence of rabbits due to the Calicivirus were a start, the grazing pressure from a large kangaroo population would remove any new growth.

In the afternoon we moved further south along the lunette to the palaeomagnetic site where Mike Barbetti while examining Aboriginal hearths found an anomalous palaeo-magnetic result. Further work revealed a short-lived shift in the magnetic field (though not a full reversal) later called the Mungo Event. Given the amount of work that has been carried out at Lake Mungo and the Willandra Lakes region as a whole there is still scope for further work. For example, with the new dating techniques now available, the existing chronology at Lake Mungo could be both revised and extended. Some further research into this area has begun at the Quaternary Dating Centre at ANU.

Another starry evening (somewhat curtailed by the northern fringe of a passing front) and it was time to head south and east. Stopping briefly to look at Chibnalwood Lakes outer lunette ('largest clay dune in the world') and the mallee vegetation we came out onto the very different environment of the Riverine Plain. After driving through the heavy rain of the front's trailing edge we were into the sun at Nyah West railway cutting. The cutting is significant in that there are few others which provide a transect through a longitudinal dune. Unfortunately, the best section was essentially destroyed when the railway engineers cut the face back to a gentler grade obscuring the stratigraphy. The original TL dating is known to be invalid and a new set of samples has been collected for processing.

Before reaching our final destination of Mathoura and the

Picnic Point Caravan Park we visited Lake Tutchewop. This is a saline water evaporation lake - part of the salinity management program for the region. Both here and during the next day we heard about the change in water regimes brought about by dam construction, clearance of forest, irrigation and other human activities which have led to serious environmental problems. At the Mathoura Bowling Club we had a good meal and Bernie, Jim and Charles Lawrence all got up (somewhat reluctantly) to make speeches to mark the event. Discussions continued back at the caravan park round a smoky fire well into the night.

The final day saw us visit Green Gully, the Cadell Fault overlooking the Barmah Forest, Barmah Sand Hills and Lake Kanyapella. Tim Stone who is doing his PhD on aspects of the area joined the group to tell us some of the work he is involved with. Having gained a quick taste of the geomorphology of the Riverine Plain it was time to separate once more for the respective journeys to Canberra and Melbourne. In a final ceremony held in a sand pit on the lunette of Little Kanyapella Lake, Bernie presented Jim with a crooked staff and suggested many interesting potential uses.

An excellent trip, due in the main to the presence of Jim and Bernie who have both the knowledge and the ability to communicate in full measure. It was a privilege for us all and future students (assuming the course continues to run) will lose much by their absence. Thanks to Jim and Bernie and also to Pauline English (aided by Tim Barrows and John Magee) in organising the Canberra connection.

Jim Bowler explaining things at Barmah Sand Hills.

If you have recently been on a field trip (whether it be related to your own research or a conference) and feel that your experiences would be of interest and/or amusing to your fellow Quaternarists then please send in an account of your adventures to Quaternary Australasia. Photos are extremely welcome!

Quaternary Project Reports

I have frequently overheard discussions about the lack of knowledge regarding international Quaternary research initiatives (such as the IGBP-PAGES PEPII program and the IGCP project 367) and even large scale projects within the Australasian region. The region is represented on many of the international project committees and data has been contributed. However, there appears to be a failure to communicate the progress of such projects to the wider Australasian Quaternary community. Whether this is a case of people not reading the appropriate newsletters or simply a matter of too much to do, too little time and not enough resources on the part of our representatives, I am not sure. Whatever the case, I felt that *Quaternary Australasia* was an ideal vehicle to communicate news and progress reports on the various large-scale Quaternary projects in which our members are involved. In this issue Geoff Hope, John Dodson, Collin Murray-Wallace and myself have filed reports on the projects and committees we are involved in. I hope to make this section of the newsletter a permanent one, so please if you have anything to contribute, no matter how brief or simple, send it in. We really would all like to know what people are involved in! [Kate Harle - Editor]

BIOME 6000 and biome modelling

by Geoff Hope

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Climate modellers have been multiplying and there are now 16 or so models at different scales available that purport to model the way the climate works. But modellers disagree on why their models disagree and it has dawned on them the if their models can simulate past climates accurately, the might then be run forward predictively. So what was the past climate life? Step 1 was to ask the palaeoenvironmental community to map their interpretations for particular time slices. This worked OK (e.g. COHMAP), but interpreted data is contradictory and prone to the prejudices of the respondents. Colin Prentice (currently at Lund University, Sweden but soon to move to Germany) has suggested that vegetation is the answer to meshing climate and palaeo-environmental data. Taking the output of a climate model, various ecological limits allow the results to be mapped as potential vegetation across the globe. Palaeoecological data, particularly pollen, are becoming widespread across the world. By applying a two step process, Colin and Sandy Harrison have provided a method by which pollen data can be converted to vegetation at the level o the biome - a structural vegetation unit that is climatically limited. The model output can thus be directly compared with the data, and analysed for sensitivity. Climate modellers have mostly welcomed this possibility. In some cases a harder nut to crack has been the pollen analysts who have been asked to dig out their original counts and expose their dates to outside eyes. Colin and Sandy have held a series of workshops to gain guidance on the reality of biomisation, bringing together palynologists and modellers. John Dodson and I went to a meeting in 1995 (he repre-senting Australia and I "the Asian tropics") and I've been to two more in 1997. In between we have set up a database for the Indopacific and are slowly getting pollen data donated. The Lund group have helped the process along by a small grant to pay to have data put into TILIA. As an initial aim, spectra from modern, 6 ka and 18 ka (radiocarbon years) have been collected. The modern spectra may be pre-industrial clearance i.e. 0-200

BP as the aim is to test the biomisation process against potential vegetation, to see how well it reflects modern climatic boundaries. The spectra for 6k and 18 k are chosen using a chronological model based on available dates, with an index for uncertainty of dating. TILIA version 2 has associated files containing all dates, site information and preferred chronology, so it is a convenient format in which to store data.

Once the spectrum is available, some taxa (aquatics, exotics) are removed and the taxa are assigned to one or more 'plant functional types' (PFT) e.g. Tropical tree (> 20°C), xerophytic shrub etc, with grass maintained as a functional type in itself. These PFT vary by region for some taxa, so local knowledge is essential. The computations (described in Prentice et al 1994) assign biomes at different levels of confidence using the PFT's. So a spectrum is transcribed into a set of biomes with probabilities. These are then mapped for comparison with the predicted climate vegetation. With dense areas of pollen sites, maps can be compared in detail. For example, in southern Sweden the boundary of boreal and temperate evergreen forest is clearly shown by pollen, lying about 150 km south of one model's prediction for 6 ka.

Current progress with the Indo-pacific data base is to identify about 400 modern, 200 6ka and 80 8 ka sites in the area from tropical India to Easter Island. Of these perhaps 25% are available as discrete pollen counts, though many more are promised. If you have spectra to donate please let Geoff Hope know. To improve the chronology, the Prentice-Harrison group have offered free AMS dates to help locate 6 and 18 ka spectra as accurately as possible. Predicted spectra can be tested if sample residue is available, or bracketing dates obtained. If you have samples (which must be supported by spectra donated to the project) contact Geoff Hope for submission details.

While BIOME 6000 calls for only 3 spectra per site plus available chronology, location and altitudes, the world Geophysical data base at Boulder, USA wants all your pollen counts in Tilia as soon as possible. We have sent ca 80 data sets to Boulder so far, but 640 have been identified for the region, so there are lots of sites to come. You can send Tilia files (with site, chron and age files attached) to boulder (NGAC) directly, or via ANU where a set is being assembled. We are happy to enter data if you wish to send us photocopies of old sites and we return the Tilia file to you. A small amount of money is available for data collation and entry if this will help.

All data in Boulder is available to everyone and co-authorship in Biome papers is available for data providers. It is planned to hold a meeting of Australian palynologists early in 1998 to discuss biomisation and check model runs. Cooperation is invited.

IGBP-PAGES

by John Dodson

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PAGES has moved forward substantially over the last 12 months in attempting to implement the Science programs that were developed in 1994-1995. The major problems in doing this has been the lack of funds, and the impediments in science funding systems in the various countries. In the Australasian (PEP-II) region China and Japan have been able to develop well-structured research programs with direct Government funding. In New Zealand Jamie Shulmeister has been successful in developing a drilling program with substantial government funding. In Australia groups at ANSTO, the Bureau of Meteorology and CSIRO

(Atmospheric Physics) and among the univer-sities are contributing toward Australia's work on past global changes. The one attempt made by Australians to obtain ARC support for a coordinated effort did not succeed. It would be nice to think that the present Government would regard global change science as some kind of priority but cuts in funding and programs for AGSO, CSIRO and the universities has made matters worse. Most countries in the region have few scientists with the necessary expertise to act as champions for global change science.

PAGES is aware of many of the structural impediments for programs on the Science plans. Frank Oldfield has coordinated a funding proposal designed to cost out each part of the PAGES plans. I understand that IGBP has asked for this to be done for all the core projects (PAGES is one of eight). The sources of money have not been identified but eventually this may lead to funding of at least some of the science. About US$16 million/year has been estimated as the real cost for all PEP-II science.
A similar amount has been costed for PEP-I, and the PEP-III transect is more expensive. There are two 1998 PAGES meetings which are of interest to AQUA members. These will be in London and Fremantle.

1. Open Forum
Royal Holloway, University of London, U.K. April 20-23, 1998. 'Past Global Changes and Their Significance for the Future'
The meeting will be organised around invited plenary presentations and high profile poster sessions. These will focus on:
i. The full range of climate system variability
ii. Climatic forcing
iii. Climate system process
iv. Modelling the climate system
v. Biotic responses to climate change
vi. Human consequences of climate change.

Participation is limited to 200 people. Those offering posters will be given priority. A poster abstract should be sent to Bern by 24th October, 1997 (see attached).

2. Pole-Equator-Pole II Meeting.
As part of the Institute of Australian Geographers Meeting at University of Notre Dame (Fremantle) - July 7th-10th, 1998, a PEP-II Symposium will be held. This will focus on:
i. Climate variability in the last two glacial cycles, and in detail over the last 2000 years
ii. History of the Australian monsoon, the Australian High and the westerlies
iii. Linkages between the Southern and Northern Hemisphere climate systems
iv. Climate variability and human impacts on biodiversity

Several international scientists have already indicated they will attend. Field trips in the SW and Shark Bay region will be held as part of the meeting.

IGCP Project 367

Late Quaternary coastal records of rapid change: application to present and future conditions

By Colin Murray-Wallace

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Now in its fourth year with one year remaining, the International Geological Correlation Program (IGCP) project number 367 entitled "Late Quaternary coastal records of rapid change: Application to present and future conditions" follows on from previous IGCP coastal projects related to Quaternary sea-level change. Since 1974, UNESCO and the International Union of Geological Sciences (IUGS) have been sponsoring, in the context of IGCP, a series of research projects related to sea level: Project 61 "Sea-level changes during the last hemicycle" (directed by A.L. Bloom, 1974 to 1982), Project 200 "Sea-level correlation and applications" (directed by P.A. Pirazzoli, 1983 to 1987), Project 274 "Coastal evolution in the Late Quaternary" (directed by O. van

de Plassche, 1988 to 1993). Project 367 "Late Quaternary coastal records of rapid change" was initiated in 1994 under the direction of Dave Scott. Each of these projects have attracted several hundred participants from 50 to 70 countries.

Whereas previous projects have focused on sea-level change for discrete time intervals or more general aspects of coastal evolution, Project 367 has been more applied with its emphasis on rapid coastal change. Project 367 arose from the perceived need to address aspects of rapid coastal change, particularly in the context of impacts on humans and is therefore directly relevant to coastal management. Some of the topics examined by participants of the project include the impacts of intense storms, coastal hazards, tsunami, seismic events, tidal changes and rapid sea-level change.

The three main objectives of project 367 as outlined in the project proposal include:

1. To document and explain rapid changes (events that occur on the scale of seconds to 1000's of years) in the Late Quaternary coastal zone. High resolution studies will be used to assess the impact of short term events on global and regional coastal change. These data will be used to suggest scenarios for future coastal changes and help in planning for possible coastline problems.

2. To provide, in final volumes and national reports, a set of reference material that documents regional and global short-term coastal events, and explain how these events relate to present and possible events in the near future.

3. To develop and prepare, through international meetings, newsletters, common data banks etc., a common approach to these studies that allows comparison of data on a world-wide basis.

As with other IGCP sponsored projects, the annual general meeting is held in a different country each year, providing the opportunity to examine aspects of the Quaternary geology of contrasting coastlines in the context of rapid change. The inaugural meeting of Project 367 was held in Scotland in 1994 followed by Antofagasta, Chile in 1995, Sydney, Australia in 1996 and Alaska earlier this year. The final meeting will be held in Greece in September 1998 (10th to 19th inclusive). Further details concerning the September 1998 meeting and associated fieldtrips can be obtained from Paolo Pirazzoli at:
CNRS-Laboratoire de Geographie Physique, 1, Place Aristide Briand, 92190 Meudon-Bellevue, France.
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Many of the participants of project 367 have been actively involved in previous IGCP coastal projects. All would agree that projects of this nature provide a wonderful opportunity to meet with colleagues from other countries and to establish new opportunities for collaborative research. Members of the present project are trying to encourage other researchers, particularly graduate students, to become involved in the project.

Recent publications that have arisen from previous annual meetings include a thematic section in *Journal of Coastal Research* Vol. 12 (4) and *Quaternary Science Reviews* Vol. 15. A volume of *Quaternary International* arising from the meeting held in Sydney in November 1996 is presently in the final stages of compilation. An abstract volume for the 1996 meeting is available from me, free upon request.

I am presently preparing a written submission for a new IGCP project to follow on from Project 367. The aim of the proposed new project is to compare and contrast the coastal records of the last interglacial maximum (oxygen isotope Substage 5e) with the present, Holocene interglacial. I would like to take this opportunity to invite you to contribute any ideas and suggestions to help strengthen the project proposal. I am confident that the newly proposed project will generate wide interest amongst coastal researchers and look forward to your input and collaboration. If you would like to become involved in IGCP Project 367 or contribute to the formulation of the project to replace IGCP367, please feel free to contact me at the address below.

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RGC-1: High resolution palaeoclimate records project

by Kate Harle (project coordinator) and Henk Heijnis (project leader)

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The High Resolution Palaeoclimate Records Project was initiated by the Environment and Physics Divisions at ANSTO in collaboration with scientists from the University of Tasmania, Monash University, Wollongong University and Adelaide University to integrate the research efforts of palaeoecologists and isotope specialists working in the southeast Asian, Australasian and Antarctic regions. The major objectives of this project are to:

1. improve the chronological control of key long palaeoecological records on a north-south transect from Indonesia, through Australia to Antarctica using U/Th and AMS radiocarbon dating techniques;

2. provide additional stable isotope information for these records;

3. correlate palaeoclimatic change from different areas within the study region and contribute to the understanding of climatic change over the past 350,000 years;

4. contribute to the prediction of short and long term climate change scenarios using the principle of the past as the key to the present.

The project will be a major contributor to the International Geosphere Biosphere Program (IGBP), especially the sub-program Past Global Changes (PAGES) PEP II transect.

The six key sites chosen for this project have been selected to reflect the spatial variation of environments in the southern hemisphere. Lying on a generalised transect running from western Java, through eastern Australia to Antarctica, they include: Rawa Danau (west Java, Indonesia); Lynch's Crater (Atherton Tableland, NE Qld, Australia); Echo Lake (Fraser Island, SE Qld, Australia); Lake Wangoom (Western Plains, Vic, Australia); Egg Lagoon (King Island, Tas, Australia); and Ellis Fjord (Antarctica)

In addition, a detailed Holocene site (Tower Hill) from the Western Plains of Victoria has been added to compliment the Egg Lagoon and Lake Wangoom sites.

The project is divided into three stages:

Stage 1 (December 1996 – December 1997) : completion of the analyses of the Lynch's Crater, Lake Wangoom, Egg Lagoon and Tower Hill sites.

Stage 2 (January 1998-January 1999) : completion of the analyses of the Rawa Danau, Echo Lake and Ellis Fjord sites.

Stage 3 (February 1999-July 1999) : synthesis of results, interpretation of regional palaeobiogeography and climatology and production of the final report.

To date, apart from delays in the radiocarbon dating and stable isotope analysis, the project stage 1 is near completion. It is expected that scientific papers resulting from the analysis of the stage 1 sites will be produced early in 1998. If you have any questions about the project please do not hesitate to contact Henk Heijnis, the project leader (email: hhx@ansto.gov.au), or Kate Harle, the project coordinator (email: khz@ansto.gov.au).

Australian Quaternary Databases
The story so far (http://rses.anu.edu.au/envgeo/AQUADATA)

by Timothy T. Barrows
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The computing world is changing at an astonishing pace. Quaternary Research is also evolving as a science and is very different now to what it was 50 years ago. With the flood of information generated by the modern global research community it is becoming increasing difficult to keep track of advances in knowledge. New techniques and data are emerging at a rate which is fundamentally changing the way we tackle the problems of reconstructing Quaternary palaeoclimates, especially in relation to modern climate change. Fortunately the Internet is providing a way to monitor this new world.

This new section of *Quaternary Australasia* will update readers on changes within the Australian Quaternary Data Homepage, a relatively new website that seeks to act as a billboard for Australian Quaternarists and provide a gateway into the Quaternary sites of the World Wide Web. Hopefully this column will also provide a forum to discuss progress in database management, computer programs and new websites.

Australian Quaternary Data Homepage update

This issue of Quaternary Australasia coincides with the first anniversary of the Australian Quaternary Climates Database (QUATDB) webpage. As many readers will recall, the database began as a joint project between the Australian Geological Survey Organisation (AGSO) and the ANU back in 1991. The project ran for 5 years and concluded during the 'restructure' of AGSO during 1996. The database lay idle for 6 months following the retrenchment of Geoff Hunt and the voluntary redundancy of Elizabeth Truswell. Geoff organised an interface for the database through the AGSO web-server to make the public aware of the databases existence, although little data was available to the browser. Late in 1996, an agreement saw management of the database transferred to myself at the Research School of Earth Sciences (RSES) at the ANU. A new webpage through RSES was designed and plans were begun to make the data from QUATDB available to the Quaternary community.

Six months later saw the arrival of the Australian Quaternary Data Archive (AQUADATA); an online database with easy access data indexed by theme and author. After the pilot system was finalised, the project to organise the remaining datasets into AQUADATA floundered due to a lack of financial support.

The Homepage for *Quaternary Australasia* was born shortly afterwards with the assistance of the Editor of *QA* at the time; Bill Boyd. This page was intended to bring AQUA into the 90's and onto the Internet. Past copies of QA were made electronically available together with updated lists of Quaternary Homepages, listservers, electronic journals, forthcoming conferences and (soon!) recent publications by Australian Quaternarists. A nexus was initiated to link this page with all other Quaternary Homepages in Australia (as this list is still far from complete, please send the address of your Homepage ASAP!). A photo album from the AQUA Biennial General Meeting at Lake Eyre (thanks to Geoff Hunt, Ellyn Cook and Kate Harle) has proved to be a particularly popular addition to the page. Photos from other Quaternary meetings/field trips are welcomed.

Why have an Australian Quaternary database?

All of the above sites are now grouped under the common heading of the Australian Quaternary Data Homepage. The year 1997 saw considerable growth within this

Homepage but there is still a long way to go before the Internet becomes an integral part of the average Australian Quaternarist's desktop. While traffic at the Homepage is steadily increasing as more researchers become aware of its existence, the response to electronic data archiving has been very disappointing. The concept of storing primary palaeoclimatic data is having difficulty finding acceptance despite its obvious advantages.

The late 1970's and early 80's saw a flurry in the growth of data repositories as computer technology became widely available. This period saw quantum leaps forward in the understanding of Quaternary climates. Among the most famous being the enormously successful international program CLIMAP which compiled vast amounts of data from both the marine and terrestrial realms to provide a comprehensive synthesis of climate during the Last Glacial Maximum (the maps published in 1981 are still frequently used unmodified in general circulation models!). The year 1981 also saw the first CLIMANZ meeting held. This epic compilation of data was the first earnest attempt to map Australia's Quaternary climates at key time-slices, mainly as function of temperature and relative water balance. The proceedings from this conference are still widely cited and was a pioneering first step at 'databasing' Australian Quaternary data.

During the last year of the Australian Quaternary Climates Database project Geoff Hunt, Michael Ayress and I worked on two projects to highlight the importance of a data repository for Australia. The first of the projects was a review of CLIMAP's reconstruction of sea-surface temperatures for our region during 18ka (Barrows et al., 1996). The maps produced for this paper demonstrated how research since 1981 has modified CLIMAP's original conclusions. This review was possible due to the archive of palaeoceanographic data stored in QUATDB at the time. Shortly afterwards, Geoff Hunt helped co-ordinate CLIMANZ IV and used QUATDB to provide base-maps (including data from CLIMANZ I) on which new results could be plotted. The maps will be a significant update of the original CLIMANZ maps (Hunt & Chappell, *in prep*).

In addition to the ability to conduct regional syntheses, which provide major leaps in understanding of regional climate change, there are other advantages to databasing. A database enables a quick review of previous work in an area where a study is about to be undertaken. The availability of original data makes diagram preparation for papers easier, especially with the increasing use of sophisticated GIS and graphing applications. As there are now well over 2000 papers published on Australasian Quaternary climate change alone (Hunt et al., 1994), it is becoming increasingly difficult to review an area comprehensively or to cover the myriad of journals and fields that Quaternary research is published under. Many modern papers simply ignore previous work in an area rather than provide a considered review.

An example of the need for databasing can be found in papers describing the distribution of planktonic foraminifera in surface sediments of the southwest Pacific Ocean. Kustanowich in the early sixties was first to describe the faunas of the area from a series of cores taken in the 1950's. He published his data in a semi-quantitative form only. Kennett followed shortly afterwards with a very similar study in the same area but also did not make his data available. Parker and Berger again included samples from the region in their landmark study in the early 70's. They published their data but unfortunately didn't count statistically significant numbers. Another foram researcher, Joern Thiede worked in the same area in the mid-1970's and compiled another separate database to construct a CLIMAP transfer function. In the early 1990's, yet another study was conducted led by Phil Weaver and another mutually exclusive dataset was compiled. Fortunately the primary data from this and Thiede's study was published recently (1997).

Despite over 40 years study in the region (and over 150 cores!), the end result is that a combined quantitative database for use in palaeoclimatic reconstructions have only begun within the last year. The research resources of Australia are too sparse to allow for this kind of duplication and loss of data.

Future of data archiving in Australia?

History has not been kind to Australian Quaternary databases. In the late 1980's Keith Crook and some colleagues began a database to document aspects of surficial geology for the Quaternary, extending back in a broad sense to the Mesozoic. The database (The Australian Surficial Geology Database) was designed to cover almost every form of Quaternary data and stored on a hard-copy card system intended to be 'computer compatible'.

Although the database initially contained many sites from the Sth Highlands, Nth Queensland and Tasmania, it has since faded into obscurity and few have even heard of it. Another database 'PASH' (PAst climates of the Southern Hemisphere) emerged early in the 1990's. This database was designed primarily to store interpretations and site information and largely ignored the supporting primary data. It found little enthusiasm in Australia although there is still some momentum for the project in South Africa.

QUATDB began in 1991 and was next to disappear following cutbacks by the federal government and this despite the fact that our tiny research community (in comparison to the US or Europe) is trying to cover almost 20% of the surface of the globe in its Quaternary research. AQUADATA is the latest attempt at a central data repository for Australian workers. Despite the momentum of the last 12 months, voluntary contributions from individual researchers to AQUADATA have been noticeably absent.

Data submission to QUATDB consisted of filling out a complex series of tables similar to those sent out to AQUA members prior to CLIMANZ IV. A very low return rate of these forms indicated that contributing would have to be made easier for it to work. The present system is simple and requires only a table of data as it has been submitted to a journal (preferably formatted according to a standard). The researcher now need not complain about lack of time as the only time required is that to attach a file to an email over a coffee at afternoon tea time. Hopefully community spirit will prevail and the data archives will burgeon with new contributions. Some hope can be seen in the recent banding together of the palynologists to standardise and store their primary data. Other disciplines can now follow the lead.

AQUADATA is currently run completely on voluntary labour which will not continue forever. Without assistance from the Quaternary community, AQUADATA may soon join previous Australian Quaternary databases and the megafauna .

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If you have something that you feel would be suitable for this column, whether it be comments or information about new programs, useful web sites, databases, your views on any of these, or anything at all to do with the information technology revolution and its application to Quaternary Research then please do not hesitate to send it to Tim who is the Information Technology Editor for QA. Tim would also be overjoyed to receive any data you have for the AQUADATA database!

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Internet News

Below are some brief notes about internet sites that I have visited in the past year. It is by no means a comprehensive list nor are they comprehensive reviews. In the future it is planned that this section will offer reviews of new websites and other information generally available over the internet. If you have recently discovered some worthwhile site on the net or have even launched a site yourself, please let Tim know and he will review it for this column. Even better, send in a review yourself! [editor]

The Quaternary Australasia homepage

If you have not already checked this site out you really should do so. Tim and Bill have put a lot of work into producing the homepage and have done a fantastic job. The recent inclusion of a photo album has added colour to the page and will perhaps give an impression of what AQUA is about to visitors to the site unfamiliar with the activities of the group. It might also encourage some of you more dormant members to attend the biannual conference, which, as the photos attest to, are generally a lot of fun, highly informative and a great chance to mingle with fellow Quaternarists from the far flung corners of the Australasian region. The next AQUA conference is in September next year on Fraser Island and promises to be as much fun as the Lake Eyre conference (see advertisement in this issue).

Field work over the internet

One of the web page highlights of this year was the live action transmitted via the internet from the high mountains of Bolivia as a team from the University of Massachusetts Climate Lab took an ice core from and installed a satellite-linked climate station on the summit of Nevado Illimani, Bolivia. Lonnie Thompson (Ohio State) led the coring effort whilst Ray Bradley's Uni of Massachusetts climate team carried out the met station installation. "Semi-live" pictures were sent back via a satellite link, with regular updates of images and reports. It was even possible to email the team in the field. All the action of the trip as well as reports and photos could be viewed (and still can) at the following site address:

http://www.geo.umass.edu/climate/sajama/sajstart.html

The equipment they used to send digital images is all described, so if anyone has a desire to broadcast their own fieldwork to the world the technological information is all there.

Geoscience links

An apparently comprehensive geoscience link was set up earlier this year at the following address. I have not been able to access it, however, and would be interested to know if anyone else can. The author(s) of the link claims that they have "… just compiled probably the most comprehensive geoscience links" so it promises to be impressive! The site address is:

http://wwei.ucsd.edu

Another geoscience resources site which I found whilst attempting to contact the above address is given below. From the brief look I had, it seemed quite comprehensive and well worth investigation.

http://www.lib.ox.ac.uk/internet/news/faq/archive/geology-faq.geosci-resources.part1.html

Bugs in the net

Also announced this year was a Quaternary Bibliography of Palaeoentomology put together by Coope, Buckland and Sadler. The site was mentioned in the last issue of QA but is worth mentioning again (if only to balance all the pollen information that appears later!). It presently contains around 1500 references (the authors welcome additions). References can be dowloaded using zippedWord or ASCII format. So for all of you who are interested in the insect side of Quaternary research check out:

http://www.umu.se/envarchlab/BUGS/QBIB/QBIBFRAM.HTM

Shareware newsletter

I was recently put onto a weekly shareware newsletter which provides regularly updated information about Australian shareware. The newsletter is called *Ganggang Weekly* - the guide

to Australian authored shareware and is run by Steven Byrne. Not everything listed is relevant to those of us researching the Quaternary but occasionally software is reviewed that is definitely useful.

To subscribe to the *Ganggang Weekly*, send an email to:

ggweekly@ganggang.com.au.

You don't need any text in the body or the subject line of the message. You will automatically be added to the distribution list.
Alternatively, go to the home page at:

http://www.ganggang.com.au

and fill in the box with your email address and hit 'Subscribe'.

For the palynologists

For an easy to access and regularly updated list of conferences that are of interest to palynologists visit the Canadian Association of Palynologists (CAP) home page and click on their upcoming conferences section. The site also reviews the activities of our Canadian pollen cousins, has a discussion and review section on internet resources as well as listing information about laboratory and equipment suppliers (which may be of use for those items difficult to acquire in Australia). The CAP homepage address is:

http://www.ualberta.ca/~abeaudoi/cap/cap.htm

or if you wish to go straight to the conference list go to:

http://www.ualberta.ca/~abeaudoi/cap/conf.htm

Southeast Australian pollen database

Whilst on the subject of pollen, the team at Monash University, in particular Peter Kershaw, Donna D'Costa and Dave Bulman, have made available through the Monash Geography & Environmental Science Homepage, the Southeast Australian pollen database. Stored in this data base are the modern (pre-European where possible) pollen data for well over a hundred sites in southeast Australia together with the climatic information for each of the sites. The database has proved extremely useful for modern analogue climatic reconstructions of pollen records in the region. The database can be accessed through the Centre for Palynology and Palaeoecology section of the Monash University Geography & Environmental Science homepage at:

http://www.geography.monash.edu.au/gpcpp.html

Mapping

It can often be frustrating trying to find computer generated maps of the region you are interested in or even of the globe. One site that I have found highly useful is *Design Map*. Developed by Tony Steinke of Charles Sturt University, this site allows you to create general maps of anywhere in the world, at a range of projections with a number of features (such as rivers, coastlines and political boundaries). Once you have created your master piece you can download it as a GIF or postscript file. Creating your maps is extremely easy, just specify a zoom factor, point and click or you can specify latitude and longitude ranges. The site is located at:

http://lorenz.mur.csu.edu.au/cgi-bin/gis/Map

Bill actually listed quite a few web sites in the last issue of QA (*Quaternary Australasia* vol. 15 no. 1), many of which I have found highly useful. The internet can be a confusing place and sometimes it is difficult to find a really relevant web site. I've certainly had my fair share of confusion over the last year and was grateful for Bill's site listing. It is a good place to start, especially as increasingly many sites are interconnected. If you do not have a copy of the last issue of *Quaternary Australasia* you can find an electronic copy on the *Quaternary Australasia* homepage at:

http://rses.anu.edu.au/envgeo/AQUADATA/quataust.htm

Quaternary studies at the Australian National University

Dispatches from Maluku I

by our anonymous correspondent

It was threatened that an unfunded academic pay rise in 1996 would lead to big adjustments in Australian Universities, but ANU has been affected very badly, even though its agreement with staff was a modest one. Despite the gathering storm clouds, in the Research School of Pacific and Asian Studies, the Director presented a serene face through the latter part of 1996 and sprang his scheme without warning or much consultation in late January 1997. He had decided that the school should downsize and create4d a priority document. To the horror of the Division of Archaeology and Natural history, all Australian and pre-Holocene work was given the lowest priority and even our Pacific prehistory only reached a C. A and B was reserved for Economics, Linguistics and history with human Geography squeaking in for some activities. Not to worry, said the Director, it is just indicative, as he steam rolled protests and refused to accept academic votes on the matter. We are puzzled, since were rated very highly in the School Review and had been alone in the school to get funds from the University for projects and capital equipment. Our budget for 1997 balanced nicely - as long as we spent nothing on equipment, fieldwork or running expenses so it was clear that some technical staff positions would be lost.

Two staff from the radiocarbon lab were affected, one resigning and the other, John Head, being made redundant. The in June the director called us in and said that the budgetary position was worse than expected and the Division must be closed as it had been "agreed" that it was low priority. This had been inevitable ever since he had created the priorities himself, but he suggested that he might keep a few people on and said all contracts would be honoured. A storm of protest arose from across the globe and the Vice Chancellor's office was lobbied to reverse the decision. Despite this, the Departments of biogeography and Geomorphology and Prehistory effectively cease to exist at the end of 1997 - a bout 35 years since they were formed. Some staff have been retained or transferred to the Research School of Earth Science using funds temporarily provided by Pacific and Asian Studies. John Chappell, Brad Pillans and several students will transfer to RSES, together with the OSL (Nigel Spooner), radiocarbon and ESR (Reiner Grun) laboratories. Remaining in the Pacific and Asian Studies are Atholl Anderson, Geoff Hope, Rhys Jones (reduced to half time for six years) and Sue O'Conner. Mike Macphail and Wal Ambrose will finish in 1998. This retains the palynology lab and some prehistory, but as staff leave the funding base declines and cuts will continue. Australia is phased out, and eventually access to the dating laboratories that were set up by the school. Although some of the long-term investment has been retained, the Australian Quaternary community will lose a major resource at ANU. Cooperative research such as SLEADS, barrier reef and Northern Rivers projects, access to equipment and advice have been effectively cut away. The major Australian discoveries of the ANU, such as Mungo, Kakadu, Lake Tyrrel, Lake George, Lake Frome and Lake Eyre, as well as pollen sites in north Queensland, the southern Alps and Tasmania will become scientific history. The older discoveries of the Pacific and southeast Asia such as Kuk, Tari, Teleformin, Baliem, Huon Terraces, Tavieuni, Plaine of Lakes must also be curtailed leaving major questions of Pleistocene biogeography, anthropogenic and climate change unanswered.

Other workers have, it is true, taken over the Australian work started at ANU, but there will be a void in island Indonesia and New Guinea. Major collections of pollen, phytoliths, bone and pottery will be less curated with time and the laboratories concerned with sediment chemistry, DNA and residues will be liable to closure in the near future.

Looked at across its 30 years of existence, Prehistory and the Quaternary part of biogeography and Geomorphology filled a void in Australian knowledge and hence were pulled away from the increasingly contemporary studies of east Asia. The destruction is vandalism by the Australian Government of course, but should be seen as an attempt by the Research School to survive by shedding its 'weirdest' parts. The cut from 96 to around 60 academics means many more are losing their jobs elsewhere in the School than in Archaeology and Natural History. A move out of the School was, in which sight, long overdue.

Quaternary studies at ANU remains, both with a new 'Department of Archaeology and Natural History" that will carry on some roles of the former Division, but also in an expanded Research School of Earth Science which has put a lot of effort into Quaternary Science over the past few years. The use of the 20 MeV tandem accelerator for Be10, Al26 and Cl 36 dating in the Department of Physics will continue, although the loss of John Stone and eventually mike Bird is a blow to isotope studies 9at least they to other jobs, rather than being fired). Now that Bob Wasson is head of Geography and Patrick De Decker continues his interests in marine and lacustrine environments in Geology with Brad Opdyke, the Faculties have a strong presence. We hope that improved communications can save the situation and keep strong collaborative work alive at ANU; there is talk of a virtual Quaternary Centre.

My own greatest regret is the lack of encouragement for a Canozoic approach on which so many biogeographic questions hinge. The possible loss of Mike Macphail, whose magnificent work across 60 my is amongst the most important done at this university, is a scientific disaster on a national scale, matched only by the massacre of Cenozic science at AGSO.

Congratulations

Congratulations to Lesley Head on her recent appointment as Associate Professor in the School of Geosciences, University of Wollongong!

Congratulations also to Drs Peter Gell and Donna D'Costa on their graduations as PhD's.

MSc Studentship

The School of Earth Sciences, Victoria University Wellington is a MSc Studentship combined with a Research Assistantship in a Quaternary application of luminescence dating.

The person will be officially supervised by Dr James Shulmeister (Quaternary Geologist) but will work extensively with Dr Olav Lian (Luminescence Dating Scientist and Quaternary Geologist) who is lab director. The ideal candidate will hold a first class honours (upper seconds acceptable) degree in Geophysics, Geology, Physical Geography or an associated cognate discipline and have strong quantitative skills.

The MSc will be by thesis only and will involve both field and laboratory research. The project will be independent to, but linked with, ongoing research in the School. The details of the project will be negotiated with the successful candidate to allow flexibility to fit individual skills and interests. The normal duration of an MSc by thesis at Victoria is 12 months, extendable to 18.

The Research Assistantship/ Scholarship is valued at $NZ7500 + domestic tuition fees. Candidates from Australia, France, Germany, New Zealand and some South Pacific nations are eligible for New Zealand domestic fees. All others will be subject to foreign student fees. The candidate will be expected to work up to 6 hours per week in the laboratory as a Research Assistant. There is a possibility that successful completion of this studentship will lead to a permanent position in the laboratory. The studentship is available immediately and will be advertised until filled.

Interested persons should contact Dr Olav Lian at “olav.lian@vuw.ac.nz".

AQUA
australasian quaternary association

Student Travel Prizes 1998

Postgraduate Travel Prize

The purpose of the prize is to support a student currently enrolled in a postgraduate degree in Australia or New Zealand in the field of Quaternary studies, who is a member of AQUA, to attend an international conference at which they will present results of their research. The intention is that attendance at the conference and the presentation should enhance the student's career and Quaternary studies in Australia and New Zealand. The successful applicant will be expected to submit a report on the conference for publication in the society journal, Quaternary Australasian.

The value of the award is A$1000. One award may be made each year.

AQUA Conference Student Travel Prizes

The purpose of the prizes is to support students from Australian or New Zealand Universities, who are members of AQUA, to present the results of their research in Quaternary Studies at the biennial AQUA Conference.

The value of the award will be up to A$500 per person.

One award will be made to an Honours student (current or graduated since the previous AQUA conference, for Honours research) and one to a currently enrolled postgraduate student (for postgraduate research) in the year of an AQUA Conference.

The next AQUA Conference will be held from 28th September 1998
on Fraser Island, Queensland.

Applications

Applications must be made on an application form available from the President of AQUA. In addition, a copy of the abstract submitted to the conference organizers must be included. Applications for membership of AQUA may be made at the same time as application for the prizes.

The awards will be competitive and the winner will be chosen on merit, by the executive committee of AQUA. AQUA reserves the right not to make an award. Proof of registration to the conference will be required before the award will be made. Where the opportunity for oral presentation exists this will be the expected form of presentation. An individual may only be awarded the prize in a category once.

Applications will be accepted until March 31st 1998
for conferences held up to March 1999.

Information and application forms

Dr Paul Hesse, School of Earth Sciences, Macquarie University, Sydney, NSW 2109, Australia. Ph. 02 9850 8384, Fax 02 9850 8420, e-mail phesse@laurel.ocs.mq.edu.au

The ANH Dismemberment Ball

Special Issues

Paleoclimates: Data and Modelling

Proceedings of the 'Climate change: retrospect and prospect. Quantifying the past to understand the future' conference, University of Melbourne, Nov 1995

Editors: A.Peter Kershaw (Department of Geography and Environmental Science, Monash University), A.Barrie Pittock (CSIRO, Division of Atmospheric Research) and Ian Simmonds (School of Earth Sciences, University of Melbourne)

The editorial below indicates how important this issue is to Australasian Quaternary researchers. Unfortunately, many university libraries may not subscribe to this relatively new journal and you may like to purchase a copy. If you do wish to purchase a copy at a reasonable price, please let me know by the end of this month (January) and I will forward the list to the publishers.

Editorial

This special issue contains a selection of papers presented at a conference entitled `Climate Change: Retrospect and Prospect. Quantifying the Past to Understand the Future' held at the University of Melbourne, November 1995. The meeting, instigated by Jim Bowler, was the latest of a number of gatherings dating back to a 1975 conference at Monash University on `Climatic Change and Variability: A Southern Perspective' (Pittock et al., 1978) and including three CLIMANZ conferences (Chappell and Grindrod, 1983; Pillans 1985; Donnelly and Wasson, 1989). These meetings were designed to bring meteorologists and oceanographers, particularly modellers, and Quaternary scientists together in order to improve reconstructions of past climates within the Australasian region.

This meeting included 25 oral presentations organised into sessions on modelling, biological data, physical data and chemical data and covered a larger proportion of the Australasian region and a greater number of methodologies than had been the case at previous meetings. In addition, several papers were devoted to the broader Pole-Equator-Pole transect 2 of the International Geosphere-Biosphere Program's Past Global Changes (PAGES) core project, reflecting the involvement of Australasian workers in the Antarctic and east Asian regions including the oceans. The meeting was also designed as a contribution to the special International Quaternary Association's Palaeoclimates of the Southern Hemisphere (PASH) project. There was healthy and constructive discussion related to a variety of topics including apparently contradictory results from lake level studies, varying estimates of glacial temperatures from temperate, arid and tropical environments, and the relative value of climatic models and palaeodata. Although it was felt that there was increasing familiarity with modelling by the proxy workers and vice versa, a situation aided by the COHMAP exercise, this was still not being translated into collaborative work within the region and should be addressed urgently.

The first paper and one that sets the scene for this issue is that by Ian Simmonds. This was presented as the keynote paper in the modelling session. Simmonds argues that climate models have a very important role to play in understanding present, past and future climates They can be used not only to simulate past climates but also to help interpret proxy evidence through tests of spatial and multi-variate consistency. Models can be used to interpolate between palaeodata, and to indicate where key new data may be found. Simmonds also points out the complexity of models, that they are rapidly evolving, and that they are far from perfect. He highlights particularly the advances in coupling dynamic models of the oceans to the atmospheric models, and the complexities of the spatial scaling problem, especially in regard to vegetation and land surfaces. He notes the increasing recognition of climatic variability on the decadal to centuries timescales, particularly by the World

Climate Research Program in its new 15-year CLIVAR program to study climatic variability and predictability. CLIVAR recognises the need for cooperation with PAGES and that modelling of the past and present behaviour of the monsoon, the El Nino-Southern Oscillation (ENSO), and the tropical Pacific warm pool within the PEP2 transect are major concerns.

Chris Reason and others take up the decadal and interdecadal variation theme in their examination of sea surface temperatures and associated variables in the Indian and Pacific Oceans. They discuss a variety of mechanisms which could induce climatic variability on these timescales. These include internal variability of the global ocean thermohaline circulation, coupled ocean-atmosphere modes, and energy transfer from short-term weather events to longer timescales in the oceans. They find, from an examination of records over the last 100years, that local thermodynamic effects of winds on ocean surface fluxes and boundary layers are important in the central tropical and sub-tropical areas (outside the near equatorial zone), whereas in the western boundary current and mid-latitude regions dynamical adjustment of the ocean subtropical gyres to atmospheric changes are important. They note that these mechanisms could operate under different climatic regimes of the past or the future.

On a more local scale, Roger Jones and others outline a method developed for modelling the water balance of closed lakes, using it to construct a record of precipitation/evaporation ratio from Holocene lake levels from crater lakes on the western plains of Victoria originally constructed from sedimentological and palaeoecological data. The model was calibrated using a 130 year historical record. A different approach to the derivation of quantitative palaeo lake and salinity levels from the western plains is taken by Peter Gell. He uses a transfer function based on an extensive modern diatom set and applied it to palaeoecological records covering much of the Holocene from a pair of crater lakes. Large fluctuations in water budgets were recorded with similar results to other lakes in the region except in the late Holocene. In view of these contrasts, and possible differences due to variation in lake morphology, he concludes that further hydrological modelling is required to explain changes in climatological terms.

A detailed study of the late Holocene is the focus of Ian Thomas's contribution. From the pollen analysis of a relatively warm sub-humid marsh in northeastern Tasmania, he identifies a short duration cooling of about 3^{o}C around 3500 BP. Thomas relates evidence for a subsequent wetter phase from an increase in *Sphagnum* moss spores and other shallow water aquatic plants to a reduction in evaporation due to cooling, and notes a peak in rainforest species approximately 400 years later due to lags in the biological system.

A comprehensive analysis of the spatial distribution of pollen records from 48 sites in the general southeast Australian region is presented by Peter Kershaw. Maps showing the relative abundance of major terrestrial pollen taxa are produced for major time slots including the Last Glacial Maximum, 12,000, 9000 and 6000 BP. Recent pre-European settlement samples are used to reflect the present climate as these are considered more reliable than modern spectra due to human impact. Results suggest a general climatic amelioration from the cold, dry and probably windy Last Glacial Maximum with temperatures similar to those of today being achieved by the early Holocene. Highest effective precipitation was reached in the mid Holocene. Differences in vegetation development between the western and eastern parts of the region suggest possible differences in atmospheric circulation patterns over time. Kershaw notes several complicating factors including fire and soil conditions (acidification and salinisation), and feels that the use of climatic modelling might enable stronger interpretation to be made.

Maureen Longmore provides much needed data from the neglected subtropics of Australia. The palynological records from perched lakes on Fraser Island off the coast of southeast Queensland are situated in a region strongly influenced by ENSO. In contrast to evidence from most other parts of the continent, these records suggest that the mid Holocene was relatively dry although not as dry as the Last Glacial Maximum and late glacial periods. There is also the suggestion that ENSO

fluctuations were an influence as early as 8500 years BP.

There has always been a problem in constructing and dating records from the extensive arid interior of Australia and this has prompted initial studies on the use of more novel methods of study. Here, Lesley Head and others describe the use and limitations of nest and midden structures from *Lepoillus* stick-nest rats from 50 sites widely scattered through the arid regions of South Australia and New South Wales for palaeoclimatic reconstruction. Extensive radiocarbon dating and classification of site types reveal that temporal resolution is a major problem, exacerbated by the rats' habit of tunnelling through the middens. Nevertheless, these widespread sites do provide one of the few palaeoclimatic indicators in desert environments from palaeoecological data.

Another important gap in the late Quaternary of Australia has been covered by the geomorphic and stratigraphic analysis of Lake Woods in the summer rainfall, semi-arid region of the Northern Territory, undertaken by Jim Bowler and others. Here, the latter part of a sequence of shoreline sand ridges, dated by multiple luminescence techniques, provides evidence of higher lake levels than those recorded during the Holocene within isotope stages 3, 5 and 7, and lake drying in between. The results have major implications for understanding the history of the monsoon system and the authors stress the need for modelling to relate these hydrological changes to the climates that controlled them.

A knowledge of the history of the Indonesian region is critical to the understanding of climate change over much of Australia and Sander van der Kaars provides summaries of, and comparisons between, the two longest and most continuous palynological records yet constructed from that part of the world. One record is from the Bandung Basin of west Java while the other is from the Banda Sea and both provide details of climate through the last glacial cycle. Of major interest is the indication from both records that precipitation was lower during the last glacial period than in the interglacials and that temperatures were significantly lower, probably by 4 to 7^{o}C, during the last glacial period.

Of significant interest to the PEP2 transect and to climate change globally are records from the Tibetan region and the final paper in this issue, by Guang-Guo Ying and Basil Johns, reports on changes in biomarkers in a palaeolake in the Zoige Basin within the eastern Qinghai-Tibet Plateau. The biomarkers indicate levels of productivity which varied widely over the last 850,000 years. They point to warm humid periods which agree well with other evidence, indicating fluctuations in the influence of the Asian Winter and Summer monsoonal regimes in the region.

We thank others involved in the organisation of the conference, particularly Jim Bowler, Bob Baird, Michel Porcher and Ian Thomas, and the Australasian Quaternary Association (AQUA), the Faculty of Arts, the Faculty of Science and the School of Earth Sciences, University of Melbourne and the Department of Geography and Environmental Science, Monash University, for financial support.

The following scientists kindly participated in the review process: Paul Bishop, Jim Bowler, Platt Bradbury, Bill Budd, Allan Chivas, John Dodson, Lesley Head, Paul Hesse, Geoff Hope, Barrie Hunt, Peter Kershaw, Jon Luly, Mike Macphail, Vera Markgraf, Louis Scott, Ian Simmonds, Roger Summons, Nigel Tapper, Bob Wasson, Peter Whetton, Martin Williams and Cathy Whitlock.

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Australian Journal of Botany

'Australian palaeoclimates: refinement of estimates from palaeobotanical data', Proceedings of the Palynological and Palaeobotanical Association of Australasia conference, Monash University, Nov 1995

Volume 45, Number 3

A special issue dedicated to the memory of Suzanne (Sue) Lawless Duigan (1924-1995). The volume consists of thirteen papers by L.A. Frakes, A.P. Kershaw, P.A. Gell, M.K. Macphail, G.J. Jordon, H.A. Martin, R.S. Hill and L.J. Scriven, M.E. Longmore, P.J. Loyd and A.P. A.P. Kershaw, G.M. McKenzie and A.P. Kershaw, D. D'Costa and A.P. Kershaw and D.R. Grocke (see flier included with this issue).

Editorial

Past climates are difficult phenomena to recreate since they leave no direct evidence in the fossil record. Additionally, only recently have we begun to realise how complex climate is and just how rudimentary current palaeoclimatic reconstruction methods are.

With this in mind a group of scientists met under the auspices of the Palynological and Palaeobotanical Association of Australasia at Monash University in November 1995 with the specific conference theme of reconstructing palaeoclimate in Australasia. This special issue of Australian Journal of Botany incorporates a selection of the papers presented at that meeting and reflects a range of the methods which have been used to reconstruct palaeoclimates and their application to a variety of geographical areas and time periods.

This issue provides and excellent cross-section of the type of research being undertaken in Australian palaeobotany. It will be of immediate interest to palaeobotanists and also to those working on contemporary plants and vegetation.

Palaeogeography, Palaeoclimatology, Palaeoecology

Late Quaternary palaeoceanography of the Australasian Region

Volume 131, Numbers 3-4

Edited by P. De Deckker

This special issue contains a variety of seventeen research papers dealing with Late Quaternary palaeoceanographic conditions and records in the Australasian Region. Authors include:

P. De Deckker, T. Correge and P. De Deckker, J. Thiede, S. Nees, H. Schulz and P. De Deckker, P.P.E. Weaver, H. Neil and L. Carter, C. Hiramatsu and P. De Deckker, M. Ayress, H. Neil, V. Passlow and K. Swanson, K. Swanson and G. van der Lingen, V. Passlow, P.P. Hesse, J.I. Marinez, S. Nees, C. Hiramatsu and P. De Deckker, H. Odada and P. Wells, V. Passlow, W. Pinzian and A.R. Chivas, K. J. Harle, A.E. Rathburn, J.J. Pichon, M.A. Ayress and P. De Deckker, and P. De Deckker.

Thesis Abstracts

The reconstruction of Quaternary vegetation and climate on King Island, Bass Strait, Australia

By Donna Marie D'Costa
Department of Geography & Environmental Science, Monash University, Clayton, Vic. 3168

Analyses of pollen, sediments, shells and bones are used to reconstruct palaeoenvironments at Egg Lagoon and Lake Flannigan, northern King Island, Bass Strait. A recent pollen database is also established for south-eastern Australia to provide a firmer basis for the interpretation of the palaeoenvironmental records. Refined climatic reconstructions from the Egg Lagoon record are based on comparisons with modern analogues represented in the recent pollen database. This procedure allows some suggestions as to likely annual temperatures and precipitation levels.

A range of dating techniques including radiocarbon, thermoluminescence, uranium/thorium, electron spin resonance and amino acid racemisation, has been applied to the Egg Lagoon sequence. Despite the application of a variety of methods, a realistic chronology for much of the Egg Lagoon sequence could not be constructed on this basis alone. Instead a preferred chronology for the Egg Lagoon record was established by reference to oxygen isotopic chronology, palaeoclimatic estimates and pollen evidence from other long records in south-eastern Australia and supported, in general terms, by the dating results.

The established chronology indicates that the sequence commences in the Early Pleistocene. There is then a major discontinuity in the sequence. Sedimentation recommences in the penultimate glacial (=oxygen isotopic stage 6) with the derived pollen record spanning most, if not all, of the last interglacial-glacial cycle, probably providing one of the most detailed pollen records for the last interglacial period in south-eastern Australia. The analysis of two cores from Egg Lagoon provides some basis for an examination of spatial as well as temporal variation in the vegetation at the site through much of this time. The presence of a number of hiatuses in the record is suspected with the record for much of the last glacial period absent. The Holocene record at Egg Lagoon is also probably condensed and possibly discontinuous. Evidence for the last 4,000 years B.P. is provided by a pollen record derived from nearby Lake Flannigan.

The following major environmental changes are evident at northern King Island. During the Early Pleistocene Egg Lagoon existed as a marine embayment with foraminiferal and malaecological assemblages similar to those of current King Island marine settings. A major discontinuity is indicated by stream incision of these marine sediments. Sedimentation recommences in the penultimate glacial (=isotopic stage 6). Regional grassland and herbfields existing under cooler and drier conditions than present are inferred. Climatic conditions similar to present were established between ~130,000 - 122,000 years B.P. (= isotopic stage 5e) with regional sclerophyll woodland or open forest present. Maximum extent of closed forest occurred under cooler (up to 2-3^{o}C less than present) and wetter (+300 - 400mm) climatic conditions between 122,000 and 110,000 years B.P. Between ~110,000 and 91,000 years B.P. a drier sclerophyll forest type was established under temperature and rainfall regimes similar to present. Between ~91,000 and 74,000 years B.P. a sclerophyll forest with an increasing Casuarinaceae and heath component occurred under similar to present annual temperature and slightly reduced annual rainfall. Between ~59,000 and 12,000 years B.P. cool and drier than present climatic conditions were established with regional grasslands and herbfields present from around 30,000 years B.P. Modern vegetation and climatic conditions were established early in the Holocene. The shorter, more detailed record from Lake Flannigan suggests that climate has been stable over the past 4,000 years B.P.

The record derived from Egg Lagoon allows some examination of the history of closed forest taxa on King Island. Closed forest taxa appear to have reached their greatest extent between 122,000 and 110,000 years B.P. under cooler and wetter than present conditions. Closed forest representation then declined, most likely due to adverse climatic conditions. The local extinction of *Nothofagus*, a tricolporate Cunoniaceae and *Tubuliflorites pleistocenicus* are suggested within the timespan represented by the Egg Lagoon sequence but the cause(s) cannot be determined with any certainty.

Microscopic charcoal from the palaeoenvironmental records provides possible evidence for the arrival of people on King Island up to 35,000 years before the earliest archaeological evidence in Tasmania, although dating uncertainties mean that increased charcoal values may be recorded at a similar time to the oldest Tasmanian archaeological evidence. Reduced charcoal levels in the Holocene coincide with archaeological and historical evidence for the abandonment of the Island by people.

The development and application of a diatom calibration set for lake salinity, Western Victoria, Australia

By Peter A. Gell
Department of Geography & Environmental Science, Monash University, Clayton, Vic. 3168

A data set of diatoms and salt lake water quality data was used to investigate the relation between diatom species and a range of water parameters. The seasonal ecology of saline lake diatoms was investigated to evaluate the representativeness of this sampling approach. These modern studies were used to reconstruct the Holocene lake history of a pair of saline, crater lakes in western Victoria.

The lakes chosen for the development of the data set ranged in salinity from 0.3 to approximately 122 gA. Canonical Correspondence Analysis in the program CANOCO determined that total salinity exerted the greatest influence on the diatom species assemblages although the proportions of major ions, themselves covariants of total salinity, were also found to be influential. Silicate, nutrient levels and pH were found to have had little influence on the species distributions.

The seasonal ecology of the diatom assemblages of three alkaline lakes of contrasting salinity and stability were examined using artificial substrates, sediment traps and phytoplankton sweeps. Clear relations were evident in the distribution and abundance of species with distance from lake shore, seasonality and temperature. Occasionally the taxa colonising fresh artificial substrates were found to be different to those persisting on neighbouring slides which had been in place for longer periods. The proportions of planktonic taxa and those colonising the artificial substrates varied with depth. *Cocconeis placentula* came to dominate the flora in the non-spring period in each lake.

Optima for total salinity, major ions and ion ratios and pH for 1 18 taxa were then computed using weighted averaging. Randomisation tests in the program CALIBRATE were used to determine the predictive capacity of the data set for each of the parameters and to derive the best optima for reconstruction from fossil assemblages. A correlation co-efficient of 0.76 between the measured and predicted salinity using component 2 optima under WA-PLS was returned.

fossil diatom records from East Basin, spanning the early to mid-Holocene to present, and West Basin covering the entire Holocene were produced. These, and the ostracod, pollen and mineralogy records from the same lakes, provide evidence for considerable limnological change through the Holocene penod in these two crater lakes. CALIBRATE was used to derive quantitative reconstructions of the water chemistry, particularly salinity, of the two lakes. The derived salinity curves were modified according to optima derived from elsewhere for two taxa, *Cyclotella caspia* and *Nitzschia liebetruthii,* for which there are specific taxonomic

difficulties. These resultant curves were compared with those published from other similar lakes.

There is consistent evidence for a rapid filling of the lakes from *ca.* 10,000 years BP. Brief reversals of this phase are evident at *ca.* 8000 to 8500 years BP at both West Basin and Lake Keilambete although the timing and duration of this evident varies. All lakes experienced mid-Holocene maximum lake levels with low salinities. In both the basin lakes, the diatom flora at this time was dominated by the planktonic taxon, *Cyclotella* aff. *caspia.* The evidence for lake salinity and level change is inconsistent between these lakes in the late Holocene. It is suggested that there may be some regional variation in climate through this period, that the lakes are responding differently to climate change or that the paleolimnological indicators used have contrasting sensitivity to salinity change. There is tentative evidence for recent increases in the salinity of both lakes. It is advocated that, for the reconstruction of the region's climate, greater emphasis should be placed on a range of suitable sites.

Other Recent Publications

Harle, K.J.Late Quaternary vegetation and climate change in southeastern Australia: palynological evidence from marine core E55-6. Palaeogeography, Palaeoclimatology, Palaeoecology 131: 465-483.

Lowe, D.J.; Green, J.D.; Northcote, T.G.; Hall, K.J. 1997. Holocene fluctuations of a meromictic lake in southern British Columbia. Quaternary Research 48: 100-113.

If you have recently published a paper or book or finished a thesis could you please send me the details and I will list them in the next issues publication section. Abstracts of finished theses are also extremely welcome!

Climatic indicators within Henschke fossil cave system, Naracoorte, South Australia

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Keywords: Pleistocene, Henschke Fossil Cave, Vertebrates, Wonambi, Biostratigraphy.

Abstract

The analysis of Pleistocene faunal assemblages from within the Henschke Fossil Cave near Naracoorte in the South East of South Australia, supports the concept of climatic change during deposition. Periodic excavations of the lower levels and several outlying but interconnected caves during 1981-1997, which followed on from excavations carried out by the South Australian Museum (Pledge 1990), resulted in a better understanding of the biostratigraphy of the cave deposits. Variations in sediments encountered during these excavations enabled a reconstruction of their sequence of deposition. The small size of Henschke Fossil Cave, and its progressive removal, enabled a relatively complete sedimentary assessment.

Sediment from the major fissure compares with that from the initial excavation (Pledge 1990). A further eleven visually different sediment forms contained fossil bone: these are briefly described and an analysis of the implied habitats of their fauna made. The presence of the fossil snake *Wonambi naracoortensis* supports the concept of a previously warmer climate.

The depositional sequence of sediments and associated faunal variations imply a longer time frame than C^{14} dates suggest. This is consistent with recent advances in dating at the Victoria Fossil Cave (Ayliffe 1997). These changes may also compare with an anomaly between the Pleistocene Ochre Cove Formation and the overlying Ngaltinga Clays South of Adelaide (Pillans pers. com.). These imply early bone deposition within some caves in the area may be as old as 400Ka.

Introduction

Henschke Quarry Fossil Cave consisted of a series of small joint-controlled phreaticcaverns and tunnels in the Oligo-Miocene Gambier Limestone of the Murray Basin (Wells et. al. 1984) at Naracoorte, South Eastern South Australia. Several caves in the quarry have produced a large quantity of Pleistocene vertebrate remains. One chamber of the Henschke Quarry Fossil Cave, excavated between 1969 and 1981under the direction of the South Australian Museum, contained sediment and fossils accumulated from a natural pitfall trap (Pledge 1990).

Subsequent to those excavations carried out by the South Australian Museum the author, assisted by family and friends, excavated an extensive system radiating from the earlier site. Work was prompted by the desire to save unexcavated fossil remains from destruction by the ongoing quarrying operations. As work progressed, good rapport between the quarry owner and the author permitted a more scientific approach. The faunal assemblage from this excavation compared significantly with those of both the earlier excavation (Pledge 1990) and that from the Victoria Fossil Cave (Wells et al.1984). Collected fossils were cleaned, prepared and sorted. Many significant specimens have been lodged with the South Australian Museum. This work has been self funded by the author and helpers.

Methods and materials

Subsequent to assisting the South Australian Museum on two occasions, and learning that the Museum's excavation was considered complete for safety reasons, permission to continue fossicking was received from the quarry owner, Mr. L. A. Henschke. In mid 1981 investigations revealed bones in an exposed cave remnant some distance to the south east of the Museum's excavation. Samples were shown to Mr. Pledge of the South Australian Museum, who later inspected the site. The sediment and bone was very different to that previously encountered by him. This sediment, described herein as "Pale sands", produced clean and well preserved bones. Excavation of this sediment along the exposed cave wall ended at a pile of quarried rubble below a small cave 4m overhead. Digging the rubble away by hand revealed red stains in a new fissure. By

excavating a small opening the bone-rich terra rossa sediments were exposed. At this time the work was motivated by the threat of destruction by the approaching quarry and any fossils collected were saved from the crusher. The excavation became a tunnel almost 20m long (see Fig.1). Shoring was necessary to secure ledges and ceiling, and a portable generator provided power for a 500w light and on occasion a lightweight electric jackhammer. As the excavation progressed, significant bones were sorted and placed in labelled cardboard boxes or press-seal plastic bags for safe transport. Five litre plastic buckets used for removal of matrix from the fissure were replaced with a boat shaped 'sled' approximately 1m long. This was hauled in and out of the fissure by ropes along a horizontal chute formed of the rubble. The contents of the 'sled' were emptied into large bags, labelled and stacked in a tandem trailer for transport and future wet sieving for smaller bones. At the far end of the tunnel the ceiling became sandier over the terra rossa sediments, and careful digging up at arms length with a plastic shovel made a self cleaning hole, breaking into the cave floor above. This proved to be the cave visible in the quarry face to the south east and connecting to the north west with the pitfall at the earlier excavation that had revealed no bones when inspected by the previous team (Pledge 1990). Poorly preserved bone material (*Bettongia* and *Macropus*) was found on the cave floor under overhanging ledges. Quarrying subsequently encroached from the side to within 2m of the far end of the tunnel. The percussion from blasting had shattered the rock beyond safety limits, and there was no option but to abandon it. Determined to find more bones, we recommenced excavation at the entry to the tunnel which was far enough from the effect of the blast to be safe to work. In haste, side alcoves had previously been bypassed to rescue as much sediment as possible. The owner had become quite enthusiastic about this project and moved the quarry workings away from the cave. Work changed from using small picks, hand trowels and banister brooms to dental probes and small brushes, as a "rescue mission" was now less urgent. The true value of these protected alcoves was now revealed. The remains of *Wonambi naracoortensis* appeared for the first time in the Henschke Fossil Cave. This proved to be the lowest level of terra rossa sediment within the major chamber, with a delta that had formed within a Pleistocene cave pond. It revealed sedimentary sequences and set the stage for this paper. Later quarrying removed the fractured section of this chamber, a large block of matrix and a significant side tunnel. Subsequently this new work face was relatively safe, so excavations recommenced. The excavations approached the pitfall, confirming a positive connection with the earlier upper excavation (Pledge 1990). Intermittent with the above excavation, there were opportunities to work to the north of the pitfall and earlier excavation. This presented a different sediment and fauna. The climax for this area came when quarrying split the tunnel lengthwise revealing a picture book layout of the formation. The exposed sediment was bristling with hundreds of bones of bettongs and other associated recent fauna. This was overlying a shallow sediment containing fauna consistent with both the earlier and current excavations (Pledge 1990, Barrie 1990). The exposure allowed daylight collecting, simply while standing on the quarry floor. From voids in the limestone above, small bones could be swept off ledges, often using a piece of straw, into plastic bags held below.

Quarrying continued, eventually leaving a pillar on the quarry floor. Approximately 3m of the upper strata had been removed and the remainder was badly fractured, so excavations were limited by safety criteria. The quarry manager on several occasions volunteered a bulldozer and excavator to modify the remnants of the cave enabling the dig to continue. The current status of the deposit shows a pillar, at the north of which is a remnant of the lower face of the pitfall and to the south a very unstable tunnel containing the last of the sediment. Completion of the excavation, requested by the owner for this year (1997), requires bulk rock removal, then a concerted effort before weather or vandals obliterate the remains.

As work progressed, excavated material was hand picked for major skeletal elements and the remainder bagged and transported. Much has subsequently been washed through various sieves. Some sandy sediment was so devoid of bone that when coarse sieved (10mm) at the quarry, a day's effort produced only a handful of bones. Some serious sieving on site was attempted but abandoned due to moist clay clogging sieves. Washed bone material was cleaned and sorted. Significant specimens were brushed with or dipped in a 10% Polyvinylacetate / water solution

or a lacquer similarly diluted with acetone. Collections were retained in "dig" lots and catalogued accordingly. A journal was kept to record the excavation and plot significant material. This was in the form of plans of the cave and frequent cross sections. Codes were adopted for the various areas all prefixed with "H" for Henschke, followed by abbreviations relating to a helper, fauna, or other pertinent feature.

On some occasions significant material was tampered with by persons unknown.

By reconstructing the mechanics of deposition a sedimentary sequence was identified. Fossils from each sediment type were listed, then compared with habitats and climatic ranges of known genera. The biology of some extinct genera gives a clear indication of preferred habitats and climatic preferences. This information was analysed by plotting temperature against rainfall with ranges overlaid for

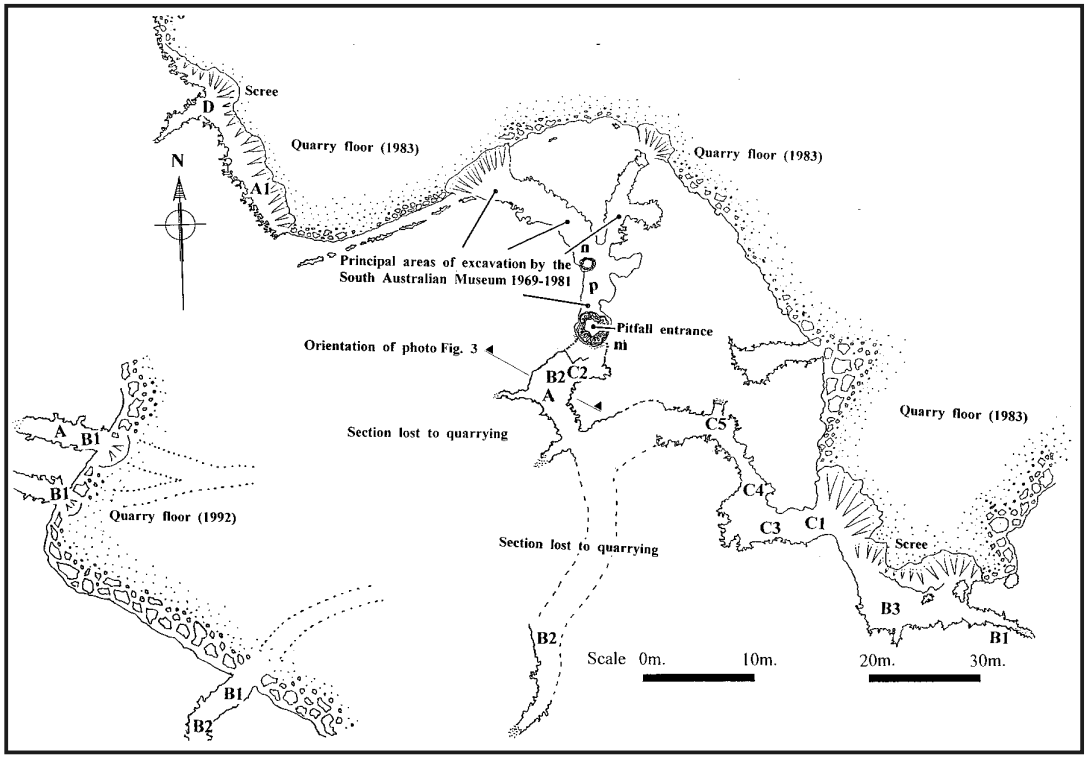

Figure 1: *Henschke Quarry Cave Naracoorte - Plan of Bone Producing Areas (see Legend for explanation of letters)*

Legend for Figures 1 & 2: geology, infilling sediments and significant features	
Infilling sediments	*Geology and significant features*
A. Green clays	e. Gambier member of the Gambier formation
B1. Dusty rubble	f. Naracoorte member of the Gambier formation
B2. Flowstone	g. Parilla sands
B3. Pale sands	h. Plio-Pleistocene beach sands
C1. Buff nodule bed	i. Bridgewater formation
C2. Pisolitic clays	j. Terra rossa soil
C3. Banded sediments	k. Pliocene solution tubes
C4. Dark muds	l. Speliothems
C5. Bone breccia	m. Pitfall entry
C6. Compacted terra rossa	n. Auxiliary excavated shaft
C7. Uncompacted terra rossa	o. Original cave entrance at quarry bench level
C8. Fawn sands	p. Original bone bed
D. Brown loam	q. 'Wombat' hole

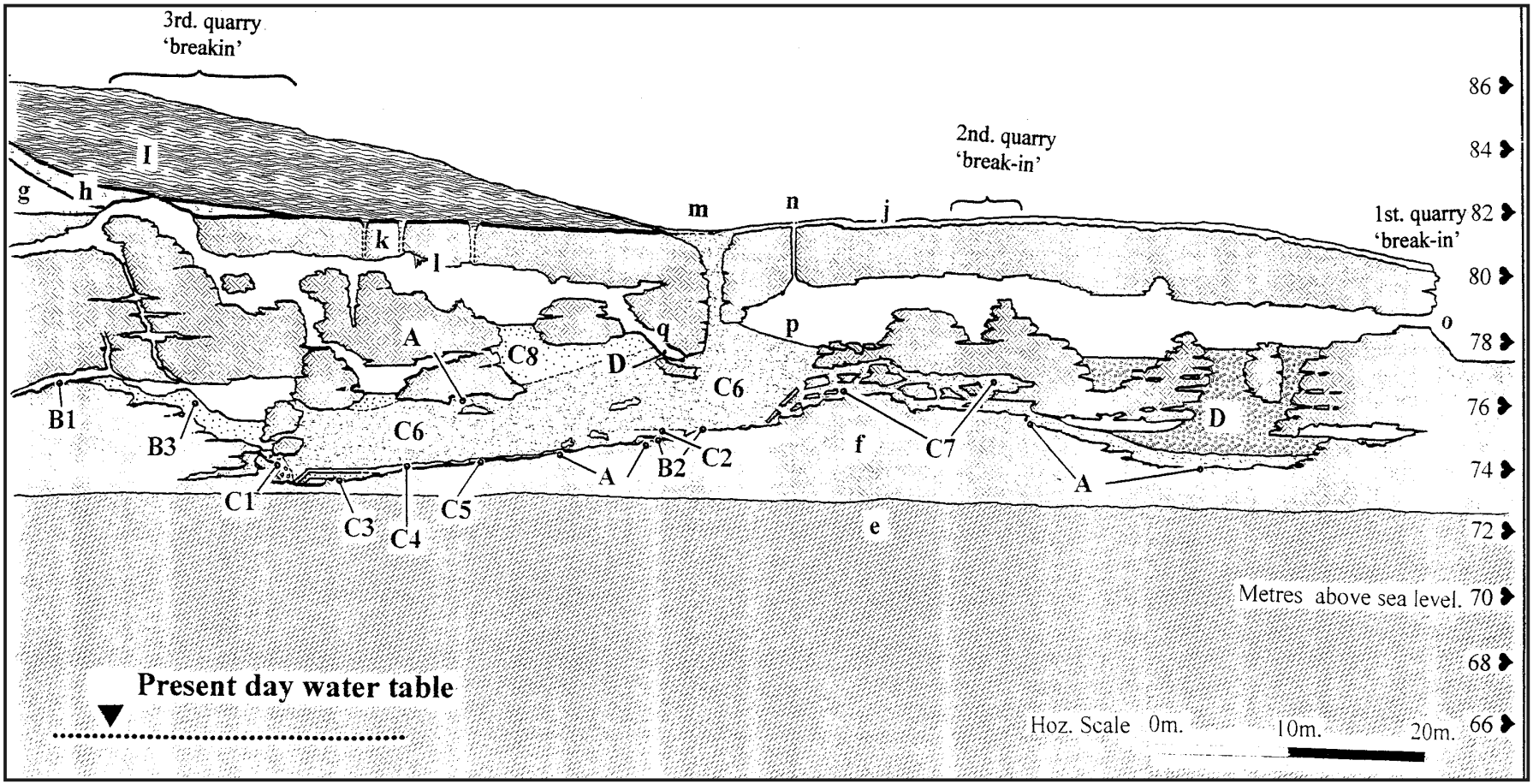

Figure 2: *Section along Henschke's fossil cave showing sediment relationships*

the selected species. Minor depositional sorting was not considered relevant to this exercise, as large and small species independently define preferred habitat and so imply climatic preferences. Sorting the faunal assemblages chronologically as determined by implied deposition sequence allowed variations in climate to be judged. These may be compared with other workers' time frames to speculate on common events.

This study is not intended to delve that far, although recent advances in dating methods may make such an analysis more meaningful in the future.

Description of cave sediments

The following are generalised descriptions of the cave sediments in chronological order, from oldest to most recent as interpreted. Sediments have been defined in four groups, prefixed as follows:-

A Predating bone deposition;
B Containing bones but no significant terra rossa sediment;
C Terra rossa sediments;
D Recent 'soils'.

Refer to longitudinal section (Fig. 2) for sediment relationship keys.
Refer to Table 1 for fauna and climatic implications.

A: Sediment predating bone deposition.

A. Green clays consisted of greenish-grey fine cracking clay with some cave detritus in shallow lenses on ledges and under cave rubble, and was < 1% of excavated volume. These clays of marine origin came from the decay of the Naracoorte Member of the Gambier Limestone. Transport of this material is likely to have been by vertical seepage, solid particles settling out on horizontal surfaces. No bone material was encountered in undisturbed green clay.

B: Sediments containing bones but no significant terra rossa sediment.

Some sedimentation could have been contemporaneous with or younger than terra rossa sediment deposition, other types predate that deposition. Pre-pitfall accumulations of bones must have arrived via another entrance, possibly near the shallow northern or western extremity of the cave system that later served the extant fossorial fauna.

B1. Dusty rubble consisted of dust, limestone rock and rock detritus with fragments of aragonite and gypsum, and was < 1% of excavated volume. This was encountered in various outlying but interconnected fissures beyond the limit of terra rossa sediments and originated from the decay of the limestone formation. Transport of this material was limited to gravity, minor air currents and possibly bio-erosion from the movement of fauna trapped or living within the cave system. Bone preserved was of poor quality but frequently consisted of associated remains of individual creatures. Material preserved in this way was not abundant but frequently exhibited rodent gnaw marks. Significant species present include the extinct large mallee fowl *Progura naracoortensis*, some rodents and small potoroid remains.

B2. Flowstone infrequently formed on cave rubble. Some flowstone was observed to contain and overlie bone material within the cave detritus and was < 1% of excavated volume. It would have precipitated from calcium rich seepage evaporating on the cave floor. A fragment of terra rossa sediment has been observed within a broken flowstone specimen. That fragment may have been from the decay of Tertiary terra rossa solution tube infill such as that from which the pitfall entrance later developed, or have been trafficked in on animals entering the cave. Bone material was fragile but relatively complete, sometimes in association, but extremely difficult to extract from flowstone. Within and below the flowstone, *Thylacoleo* and *Sthenurus spp*. were dominant. Flowstone barren of bone material was also observed, some clearly predating bone deposition. Pledge (1997 pers. comm.) reports flowstone within the terra rossa sediment adjacent the pitfall.

B3. Pale sands consisted of fine yellow to pale buff coloured sands and was ≅2% of excavated volume. This material had accumulated at the far end (south east) of the bone rich tunnel in a sloping bank that ascended on ledges to over 2m. above the lowest level excavated. Although quarrying had removed the upper cave section prior to the author's involvement, Cave Exploration Group surveys (Cundy 1974-1978) show the cave extending up out of the Naracoorte member. The cave ceiling here consists of the Plio.-Pleistocene beach sands and the Bridgewater Formation. This provided sand with an easy entry through fissures into the lower cave. Bones recovered from the drier upper zone were well preserved, clear of any calcite patina but frequently with manganese staining. Bones from the lower damp zone were extremely fragile, teeth

frequently being the only recoverable material. A large number of animal remains were contained within these sands, in particular, *Megalibgwilia*, *Sthenurus, Sarcophilus, Vombatus, Thylacinus, Thylacoleo, Phascolarctos* and rodents. It is of note that *Macropus* spp. were rare within this material but were dominant in the terra rossa derived sediments.

C: Terra rossa sediments

Terra rossa sediments comprised the bulk of the accumulated sediment (over 90%) and conformed with those described Pledge (1990). Terra rossa soils have been observed to accumulate on limestone surfaces downwind from swampy or claypan areas (Sheard 1997, pers. comm.). Its contribution to the Tertiary solution tube infill beneath the Parilla sands and the Bridgewater Formation indicates a Tertiary origin. It continues, however, to accumulate in favourable situations. All terra rossa sediments appear to have entered via the pitfall, except the one trace within flowstone (see B2 above and Fig. 2). Traces of charcoal were common. The terra rossa sediments had eight subclasses. C1 Buff nodule bed; C2 Pisolitic material; C3 Banded sediments; C4 Dark mud; C5 Bone breccia; C6 and C7 The contemporaneous compacted and uncompacted sediments; C8 Fawn sands.

C1. Buff nodule bed consisted of sandy buff sediments in which the bone was frequently encapsulated in nodules as if the bone was a catalyst to the hardening process. This was at the interface of the pale sands and the limit of the terra rossa infill adjacent to the lowest level excavated, and was <1% of excavated volume. This material was derived from a mixing of the 'pale sand' and 'terra rossa' at a level that would have been saturated when water lay in the cave pond. A significant amount of bone material was well preserved, sometimes in articulation within the nodules which were soft enough to remove with little difficulty. Significant genera included *Thylacoleo* and *Thylacinus*. A large boulder had been displaced and dropped onto this layer, crushing fossil remains beneath and possibly limiting future sediment and faunal movement along the tunnel.

Figure 3: *The vertical section of the cave sediment looking north towards the pit fall trap.*
The upper tunnel is above to the right (out of picture). The paint brush rests on flowstone that cements the cave floor rubble, under which the oldest bone is preserved. Immediately above is the Pisolitic terra rossa sediment which is overlaid by the compacted terra rossa sediment.
The alcoves preserving un-compacted terra rossa sediment are seen on both sides. The white patches in the upper centre are a combination of bones and bands of calcification in the sediment.

C2. Pisolitic clays (see Fig 2.) were present in a small band but only close to the pitfall opening. They consisted of terra rossa sediments that had been modified and were again <1% of excavated volume. This material represents some of the earliest terra fossa infilling

within the system and would have been transported by wind, water and gravity. One mechanism that can lead to the formation of such granular material is heat, Wilkinson (1997 pers. com.) Since the only such sediment is close to and down the inclined tunnel to the south east of the pitfall entrance, the most likely source of heat is from the burning of accumulated litter, the charcoal evidence being washed further into the cave in subsequent events. A small quantity of relatively complete bone material was preserved. It included a partial articulate skeleton and other scattered elements of the large extinct echidna *Megalibgwilia ramsayi.*

C3. Banded sediments were excavated adjacent to the buff nodule bed, amongst a scattering of boulders in an alcove at the lowest excavated level. Horizontally banded sediments formed a delta and spilled into a cave pond at the south east edge. There were six bands all of terra rossa origin, characterised by variations of sands, charcoal and thickness which surrounded irregular boulders up to 1m across, making excavation and analysis difficult. These sediments produced the scattered remains of the most complete specimen of the large snake *Wonambi naracoortensis.* Remains within the delta sediments displayed a number of curiosities, with some displaying erosion and hardened mud tunnels consistent with termite activity, some bones appearing eroded (thin elements were perforated), and all were coated in a stubborn patina of calcite. Other significant genera present include *Propleopus, Aepyprymnus* and numerous rodents.

C4. Dark muds to the west of the Banded sediments (C3) were very rich in bones and at the time of excavation were wet from recent rains. Being almost black they were likely to have had a higher organic content, a feature absent in most of the deposit. Genera included *Sthenurus spp., Macropus spp., Thylacoleo, Palorchestes*, *Vombatus* and various members of the families Peramelidae, Potoroidae, Elapidae and rodents.

C5. Bone breccia adjacent to the above material (C4), was a recalcified phosphate-rich floor sediment containing a mass of broken bone and tooth fragments. This was present only below potential corridors within the fissure. Trampling by *Thylacoleo, Sarcophilus, Thylacinus*, and *Vombatus* on a wet rubble floor would further damage bones subsequent to carnivore activity. Fragments of the above genera were found within this breccia.

C6. Compacted terra rossa sediments were present in the main chamber from the delta to the pitfall and to the north (see figure 2). Compaction varied with the depth of sediment, and potential bio-access (animals moving within the former cave). Some areas were re-calcified to a firm bone breccia (largely uncrushed bones), making excavation of the material difficult, its hardness and barrenness discouraging a southern extension of the earlier excavation. Transport of this material would have been by water, slumping of mud and bio-erosion. Bones were numerous in the lowest sediment but infrequent in the bulk. Preservation was variable, many bones appearing to have weathered severely prior to burial. This is consistent with recent surface material observed by the author within other caves. Degradation of bone was noticeably more advanced in the majority of material deposited closer to the pitfall, these bones probably remaining as surface litter within the fissure for some time prior to burial. Pledge (1990) reports such an abundance of bone fragments in the earlier excavation adjacent to the pitfall. Macropods are the dominant species, but *Diprotodon, Zygomaturus, Propleopus, Vombatus* and most other species recorded from the cave system are represented, the notable exceptions being the absence of *Lasiorhinus* and *Bettongia sp.* cf. *B. lesueur.*

C7. Uncompacted terra rossa sediments were encountered in alcoves, under and behind overhanging ledges. This represents approximately 2% of excavated material, its origin and transport as for (C6.). These areas contained well-preserved specimens, sometimes articulated and often undamaged. Although this sediment is likely to have been water transported, protection from the activity of organisms left it friable. A large quantity of bones were recovered from such locations; however, in terms of sequence it is conspecific with (C6). Many smaller and more fragile animal remains were collected from these sediments. The species

generally are the same as those in (C6) and those described by Pledge (1990) from the earlier excavation, but lacking *Lasiorhinus* and *Bettongia* sp. cf *B. lesueur.*

C8. Fawn sands in the upper level resulted from the mixing of some terra rossa sediment with sands from the Bridgewater formation above. It was here that an access was dug up into the floor of the cave above, (see Fig. 2,C8) It contained very few bones but *Zygomaturus* and *Macropus* were represented. This was distinguished from the "pale sands" (B3) by its darker colour, coarse texture, associated cave detritus and bones having a heavy patina of calcite.

D: Brown sandy loams of recent origin

D. Brown loamy "soil" predominates in the upper levels of the northern extremity of the system, where it forms the floor of the northern section of the tunnel, partially filling the cave voids below. It also occurs in the floor of the small tunnel exiting to the south of the pitfall where very compacted terra rossa sediment is overlain by rubbly cave detritus then brown sandy loam. This small tunnel has its eastern wall and ceiling of Gambier limestone, (Naracoorte member) and it's western wall is compacted terra rossa sediment. The terra rossa sediment extended about two metres to the west of this tunnel and was almost four metres deep at this point. The small tunnel's configuration suggests that it was excavated by wombats along the hanging wall after the pitfall had finally sealed. It then remained open for a considerable time allowing the accumulation of detritus on the tunnel floor before the deposition of the Brown loam. The entrance into the northern chamber subsequently collapsed or silted up at the pitfall. The fossil fauna within this sediment contains only extant species. The mostly fossorial animals indicate a change in mode of deposition, and selection criteria at variance with the remainder of the deposit. The pitfall mechanism no longer contributes to the accumulation and is likely to have been long since sealed. *Lasiorhinus* sp. cf. *L. krefftii* continues to appear, *Bettongia* sp. cf. *B. lesueur* is dominant with the remains of many individuals represented. Other potoroids all but disappear, possibly due to their non-fossorial nature. Common groups include Rodents, Peramelidae, small Dasyuridae and skinks. Frogs are particularly abundant though scarce in the remainder of the system.

Discussion and results

Sediment A.

The undisturbed early clays contain no bone material. These clays derive from the limestone as a result of cave formation, being left after the limestone has dissolved away Leaching from the limestone would have been accelerated by increased downward ground water movement. No evidence of recent deposition was found, possibly a result of drier climate or lack of clay remaining in-situ. Mixing of these clays with other sediments contributed to the stickiness that made sieving difficult. Where undisturbed they imply that the cave was not open to the outside at the time of deposition, since otherwise they would be greatly diluted and masked by incoming terrigenous sediments.

Sediments B1, B2 and B3

These contain the oldest animal remains, most predated the opening of the pitfall. If the pitfall was the only entrance, bones could not enter to accumulate under and within flowstone in close proximity to the entrance without contamination by incoming terra rossa sediment. Most animal remains must have entered through an undefined access possibly to the north or west were the cave system is more shallow and the weathered scarp of the Kanawinka Fault drops away. Some bone rich flowstone deposition clearly pre-dated the deposition of terra rossa sediment within the cave as much was immediately below and in close proximity to the pitfall through which the terra rossa entered. Flowstone deposition needed moisture to pass through the strata, moderate rainfall could be depleted by the suggested heavier vegetation cover. The carbonate deposition implies a period of greater than present precipitation. The rubble and pale sands could accumulate dry but would be little affected by water if present. Some animals not represented or very scarce in these sediments are of interest. Macropods were scarce but *Lasiorhinus, Bettongia* sp. cf. *B. lesueur, Diprotodon* and *Zygomaturus* were absent.

It is interesting to note some of the animals that could have sought refuge in the cave via a horizontal

entrance, ie., *Thylacoleo, Megalibgwilia, Sarcophilus, Thylacinus, Vombatus.* and the smaller potoroids, dasyurids, peramelids, and rodents etc. This displays a bias towards medium-sized carnivores *Thylacoleo, Sarcophilus, Thylacinus* and *Dasyurids* that could well have transported their prey, kangaroos etc. into the extremities of the cave. *Macropus, Sthenurus* and *Phascolarctos* are less likely to have entered voluntarily. The scarcity of large macropods is significant as is the abundance of Sthenurines. The habitat at that time favoured browsers over grazers. Common wombats (*Vombatus*) were plentiful, but hairy-nosed wombats (*Lasiorhinus*) were absent, again showing a woodland habitat bias, not grassland.

Sediments C1, C2, C3, C4, C5, C6, C7 & C8
In these sediments there is a change of species balance. In the lowest levels the large snake *Wonambi naracoortensis* is represented by two individuals, *Palorchestes* by two, *Diprotodon* by two, *Zygomaturus* by at least five, *Propleopus* by three and *Vombatus* by ten. At the extreme upper level we find for the first time *Lasiorhinus* but no more *Vombatus*. The lower (early) terra rossa deposition indicates the presence of water in the cave by the formation of the delta (Banded sediments) associated with the nodule bed, dark mud and fragmented bone "breccia". This again implies good rainfall or a higher watertable.

The bulk of the deposit is the upper (later) terra rossa soils (C6-C7) that now contain an abundance of large *Macropus* species such as *M. giganteus* and *M. rufogriseus.* Being grazers, these suggest an increase in the area of grassland. The only *Lasiorhinus* material found south of the pitfall (a relatively complete skeleton) was collected by the author at a high level adjacent to the pitfall entry. Being fossorial it may have burrowed from the northern chamber after the pitfall was finally sealed. Pledge (1990) records *Lasiorhinus* throughout the whole of C6-C7 in the northern chamber as with Vombatus but more common at the top. This suggests the extent of recent reworking of those sediments by the hairy nosed wombats and other extant fossorial animals in that chamber. This wombat as noted by Pledge (1990) has unusually broad upper incisors that compare favourably with those of *L. barnardi* now grouped with *L. krefftii*, the extant Queensland hairy-nosed wombat. (Wilkinson pers. comm. 1989). It is not referable to the extant hairy nosed wombat *Lasiorhinus latifrons.* The terra rossa sediments were deposited intermittently through the pitfall entrance in a sequence of sediment cones and subsequent slumping as described by Wells et al. (1984). Reworking of the sediment by water and bio-activity scattered most bones. It is likely that various modes of bone deposition were simultaneous, i.e. carnivores carrying prey in, animals dying in the cave, falling into it or their remains being transported to the pitfall. It is of note that *Bettongia* sp. cf. *B. lesueur* is absent in the terra rossa sediments south of the pitfall but is recorded from the contemporaneous South Australian Museum site sediments. The fossorial fauna of the 'brown loam' had access to the surface of the Museum site, so within its upper sediment, fauna representing different time frames have mixed.

Sediment D
The lack of extinct species suggests these sediments were deposited recently. The dominant species is *Bettongia* sp. cf. *B. lesueur*, which is both fossorial and of arid / semi-arid habitat.Sediments within this north-west part of the cave resulted from faeces and other organic material mixing with cave debris, the sediments were 'tilled' by the burrowing animals incorporating organic matter not evident in most sediments deeper in the system. It becomes clear that activity was not limited to this northern extremity but these recent cave inhabitants had access to the remaining cave system to the south east as far as the sealed 'Pitfall' opening, and beyond through the since collapsed upper tunnel and cave. In the confines of the southern upper tunnel a small layer of "brown loam" was present. The volume of organic material deposited into and mixed with the surface sediments reduced dramatically farther from the northern entrance. Animal activity contributed to "bio-erosion" (Pledge 1990) and disturbed the upper layers of the older fill, obliterating signs of layering within those sediments. They also added their recent remains to the earlier deposit making interpretation of the early excavation very difficult.

Table 1: *Principal faunal assemblages in implied depositional sequence of sediment groups A,B,C,D.*
Refer to Fig. 2 for sediment relationships
Interpretation can only represent periods of deposition; conditions during non-depositional phases could be very different, e.g. Ice ages.

Sediment type and significant fauna	Implied temp and rainfall	Habitat
D. Contained *Lasiorhinus* sp cf. *L. Krefftii*, *Bettongia* sp. cf. *B. lesueur*, rodents, peramelids, *Antechinus*, skinks and frogs. UPPERMOST SEDIMENT- following major lapse in deposition and megafaunal extinctions.	Coolest driest	Open Woodland-Grassland
C8. Fawn sands *Zygomaturus* and *Macropus.*	Cool dry	Woodland Grassland
C7. Uncompacted terra rossa sediments contained similar fauna to C6 plus more fragile elements including frogs and possums.	Cool dry	Woodland-Grassland
C6. Compacted terra rossa sediments contained Macropods, *Diprotodon*, *Zygomaturus*, *Megalibgwilia*, *Wallabia*, *Protemnodon*, *Propleopus*, *Phascolarctos* and many others. (*Lasiorhinus* sp. cf *L. krefftii* in extreme upper level.) See also Pledge (1990) for other species present.	Cool dry	Woodland-Grassland
C5. Bone breccia contained *Thylacoleo*, *Sarcophilus*, *Thylacinus* and *Vombatus.*	Cool wet	Woodland-Grassland
C4. Dark muds contained *Sthenurus*, *Macropus*, *Thylacoleo*, *Palorchestes*, potoroids, rodents, peramelids, elapids and *Vombatus*.	Cool wet	Woodland-Grassland
C3. Banded sediments contained *Wonambi*, potoroid (inc. *Propleopus* and *Aepyprymnus*,) and numerous rodents.	Warm wet	Woodland
C2. Pisolitic clays contained *Megalibgwilia*.	Warm	Woodland
C1. Buff nodule bed contained *Thylacoleo* and *Thylacinus*.	Warm wet	Woodland
B3. Pale sands contained *Megalibgwilia*, *Sthenurus*, *Sarcophilus*, *Vombatus*, *Thylacinus*, *Thylacoleo*, *Phascolarctos* and rodents.	Warm	Woodland
B2. Flowstone contained *Thylacoleo* and S*thenurus* spp.	Warm wet	Woodland
B1. Dusty rubble contained *Progura*, potoroids and rodents	?	Woodland
A. The green clays. No fauna represented within undisturbed clay. Cave not open to outside influences. LOWEST SEDIMENT	n/a	n/a

Burbidge (1983) reports colonies in adjacent Victoria during historic times, so this bettong, as a climate indicator, suggests the district may not have been more arid than it is today. The hairy-nosed wombat's *(Lasiorhinus* sp. cf. *L. krefftii*) nearest living kin inhabits grassy Eucalypt and Acacia woodland and was known in historic times from southern central Queensland and southern central New South Wales (Burbidge 1983). The only remaining population is in central Queensland near Clermont. Its habitat is less arid than the southern hairy-nosed wombat (*Lasiorhinus latifrons*), which ranges from the north-west River Murray districts to the Nullarbor Plain. This range is much drier than the Naracoorte district is today.

Large carnivores did not find their way into this section during deposition of the 'soils'. The recent entrance may have been too small for them, or they may have been locally extinct. However large macropods are likely, as in historic times, to have been abundant in the area but poorly represented in the most recent sediments.

General notes on the Mechanics of deposition

Now that some of the many factors contributing to the deposition and preservation of bones in caves have been recognised there can be a better assessment of the mode of accumulation and implications of past climatic changes demonstrated by the biostratigraphy at Henschke's Fossil Cave.

The pitfall trap was well formed rimmed with a funnel of lose sand. Within the cave, a carnivore's lair is evidenced by the trackways preserved in corridors and the frequent tooth-marked and often fragmented bones in these lower layers. Carnivores are more efficient than wind and water at delivering bone material deep into caves, much surviving unweathered until buried. Even large animals like *Diprotodon* and *Zygomaturus* would be disabled if wedged into the 1m by 1.5m pitfall entrance, surrounded by a sand funnel, their remains falling to the cave floor as they decomposed or were scavenged. Although it could be argued that they may have more easily avoided such large openings as appears to have served the Victoria Fossil Cave, the abundance of *Zygomaturus* remains in the latter there suggests otherwise. The absence of *Diprotodon* in the Victoria Fossil Cave suggests both a time and environmental differential between these two deposits.

It is likely that few bones arrived as surface wash, as such a small area served as a water-shed, less than one hectare (Pledge 1990) and the incline was insufficient to provide efficient water transport. The reported mass deposition of sediment during excavation (Pledge op. cit.) was enhanced by the denuded watershed and mounds of freshly sieved sediments surrounding the pitfall entry as observed by the author in 1981. With a vegetated watershed, transport and deposition of sediment through the pitfall would have been less dramatic.

***Wonambi* as a climatic indicator?**

Wonambi naracoortensis was a large constrictor of the boid (madtsoid) family of snakes. It was about six metres long with a disproportionately large girth, approaching three-quarters of a metre. Comparative studies (Barrie 1990) demonstrate it to have been a 'Gondwanan' survivor.It is grouped with a diverse group of smaller snakes surviving in outlying populations largely isolated from potential migration routes since the separation of the Southern continents. It is similar to scattered fossil remains of madtsoids of Gondwanan origin.Extant snakes of comparable size are the Reticulated Python (*Python reticulatus*) from South East Asia and Anaconda (*Eunectes murinus*) of South America. Both inhabit much warmer areas than currently believed to have existed in the South East of South Australia within the depositional time frame.

The lowest sediment levels, which contain *Wonambi naracoortensis,* show evidence of the presence of water in the cave. Such large snakes rarely venture far from water. This cave pond resulted possibly from effects of a higher sea level than today, higher rainfall or greater ground water recharge, or maybe all three. The current water table is approximately 8 metres (G. Henschke, 1997, pers. comm.) below the level of the former cave pool. The depression (known locally as Frog Hollow), between the weathered remnant of the uplifted Kanawinka fault within which the quarry and cave system lie and the Naracoorte West Dune, would have likely been an open body of water with an 8m higher water table. This implies a greater vegetation cover around its margin, the resulting micro-climates enhancing the food chain. *Wonambi's* presence during wet times is no surprise, but all extant snakes of comparable size inhabit much warmer regions. That *Wonambi*'s remains have been found within suggests caves were used as a cool refuge,

implying warmer climate. The distribution of fossil remains of *Wonambi* now includes several localities across Australia, both southern and northern. Other madtsoids are known from Riversleigh in Queensland (Scanlon 1994, pers. com.) and Bullock Creek in the Northern Territory (Scanlon 1992). Climatic changes implied by the presence of *Wonambi* are therefore not localised events. If *Wonambi* was present for only a limited time in southern Australia, its presence in the upper sediments of the Victoria Fossil Cave would confirm a time correlation with the lower Henschke Fossil Cave fauna. Remains from the 'Corralyn Cave', are referable to *Wonambi* but are believed to be late Miocene in age (Pledge 1992).

Other species implying earlier warmer habitat

The large extinct long beaked echidna of Australia, *Megalibgwilia ramsayi* is comparable to the extant *Zaglossus bruijni,* which occupies a narrow zone of humid montane forests of New Guinea (Van Deusen and George 1969). *Megalibgwilia* is well represented in the Henschke Fossil Cave (Griffiths 1991) and is likely to have required similar warm moist habitat. Its absence in recent deposits has likely resulted from its extinction at the onset of comparatively cool aridity. *Palorchestes* specimens from the lower level are described by Pledge (1991). The species appears to mimic in the form of its skull the extant *Tapirus,* also dependant on a warmer climate, and disappeared from the fossil record along with *Wonambi*. Sthenurines were browsers therefore their dominance in the earlier sediments implies wetter climates. *Macropus* spp. dominated in the more recent Terra Rossa accumulation, although they co-existed with small Sthenurines for the duration of that deposition.

The arrival of *Lasiorhinus* and *Bettongia* sp. cf. *B. lesueur* in the upper 'Brown Loams' supports the onset of comparative aridity. Although *Lasiorhinus* occurs throughout C6 in the northern chamber (Pledge 1990), its occurrence there appears to be the result of recent reworking of that section of the deposit by such animals.

Supporting climatic data

Studies by Pillans (pers comm 1997) imply a significant climatic change between the deposition of the highly leached late Pleistocene Ochre Cove Formation sediments and the overlying calcareous Ngaltinga clays in exposures south of Adelaide. The suggested time frame for this change is 400Ka. and is within the range of speleothem dates derived from flowstone associated with bones in the Naracoorte caves (Ayliffe 1997). Bone deposition at Henschke Fossil Cave may have commenced as early as that, as the accuracy of δC^{14} dates (between 30 and 40Ka (Pledge 1990)) are at the limit of the technique and are questionable in view of improved dating techniques.

SUMMARY

The sedimentation described above demonstrates that animal remains were accumulating in this cave system prior to the opening of the pitfall. This did not predate the formation of the terra rossa soils of the area, as such soil contributed to the infill of tertiary solution tubes clearly predating the Pliocene Parilla sands. At least one access (prior to the formation of the pitfall) was available to medium sized animals ie. *Thylacoleo*. This early access may have been a branch of the cave system that exits to the west of the pitfall and was visible in the wall of the quarry loading ramp west of Fig. 1, or the north western extremity of the tunnel. In recent times such an access was used by fossorial animals near where quarrying originally broke through, (see fig. 2). The cave's shallow position and the surface decline met to provide an intermittent cave access, but its configuration did not aid sediment build up as dramatically as did the pitfall. Other points of access may have contributed but remain undefined.

Comparisons between the fauna of Henschke Fossil Cave and the Victoria Fossil Cave hint at an overlapping time frame. Two significant species found in both deposits are *Wonambi naracoortensis* and *Palorchestes sp.* It is of interest that they are only present in the lowest sediment at Henschke Fossil Cave, but are present in the upper levels of the Victoria Fossil Cave.
The absence of *Diprotodon* in the latter deposit suggests it arrived in the Naracoorte district after the Victoria Fossil Cave deposit had sealed. Being well represented in more arid areas, *Diprotodon* would be favoured by increasing aridity in the Naracoorte area, thus its occurrence in the later Henschke Fossil Cave.

Aridity is a possible cause for the dwarfing of species. Observations of fossils from both the above mentioned deposits shows that in the Victoria Fossil Cave there is a higher percentage of larger *Sthenurines* present than from Henschke Fossil cave.
Within Henschke Fossil Cave the ratio of browsers to grazers decreases from the lower level to the bulk of the Terra Rossa

sediments where macropods (grazers) predominate. In the Victoria Fossil Cave the ratio compares more closely with the lowest levels at Henschke's. This suggests a significant climatic change during the major deposition at Henschke's but after the final sealing of the Victoria Fossil Cave. This aridification was sufficient to dwarf species, change woodland to a more open grassland dominated habitat, and see new species like *Diprotodon* arrive.

Wonambi's remains, though scarce, are widely distributed across Australia indicating that any implied climatic relationship between this large snake's presence and warmer temperatures was not a localised event.

The degree of aridity evidenced by the recent fauna equates with today's climate, so the faunal changes seen in this cave system suggest climatic conditions were both wetter and warmer during the early period of deposition. A disconformity in deposition is evident between the sealing of the pitfall entrance and entry of the recent fauna preserved in the 'Brown loam'. The time frame for this lapse of deposition is likely to have been significant.
The possibility that the final deposition within this cave was of a fauna modified by changed vegetation due to fire-stick farming by aboriginals cannot be discounted.

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Preliminary micropalaeontological study from Lake Clayton North, Lake Eyre Basin.

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Abstract:
A study of the microfossils present in core LE 91/1 from Lake Clayton (located in the Lake Eyre Basin) was undertaken. Species of Foraminifera, Ostracoda, Gastropoda and charophytes present throughout the core indicate that the lake remained saline from the first time it flooded over the Etadunna Formation (a Miocene dolomitic clay unit) until the latest period represented in the core.

Introduction

Lake Clayton is located in the Lake Eyre Basin, adjoining the Madigan Gulf area of Lake Eyre North (see Figure 1). The lake is approximately 30 kilometres long, with its long axis located along a southeasterly direction. A core was taken at West Head, on the northern shore of the lake. The location of Lake Clayton and the West Head Core (LE 91/1) are shown in Figure 2.

A study of the microfossils from Lake Clayton has been undertaken as part of a wider micropalaeontological investigation of past environments and lake conditions in the southeastern portion of Lake Eyre. As a preliminary investigation, 21 samples were taken from the various facies represented in

the West Head core, to examine the Ostracoda, Foraminifera, Gastropoda and charophyte remains.

Methods

Samples from the core were covered with a 3 % solution of hydrogen peroxide (H_2O_2). This solution easily disaggregates unconsolidated sediments and organic matter, so calcareous microfossils within samples can be retained. Once the samples had been adequately disaggregated, they were sieved through a 120 micron sieve. This sieve size was suitable to remove all clay particles, while still retaining a high proportion of the smallest microfossils. Once sieved, the samples were placed in an oven to dry at 75 ^{O}C for a period of 15 to 20 minutes.

When dried, the samples were then placed in small glass vials ready for examination under a binocular microscope.

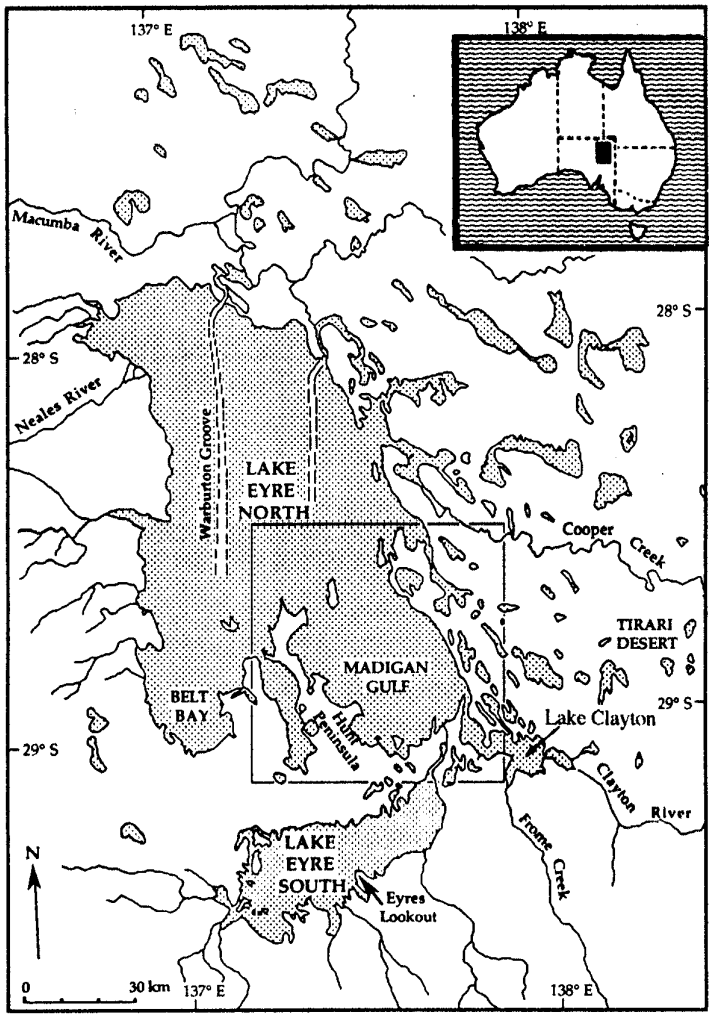

Figure 1: *The location and main features of Lake Eyre. The madigan Gulf inset indicates the location of Figure 2. Adapted from Magee et al. (1995).*

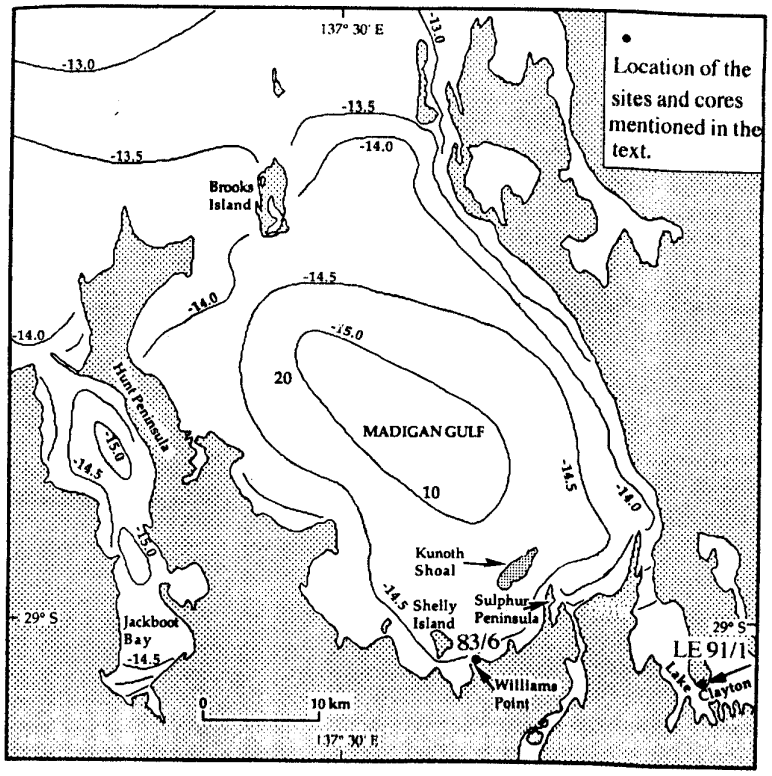

Figure 2: *The Madigan Gulf area of Lake Eyre, showing the location of cores and sites mentioned in the text. Topographic contours (in m AHD). Adapted from Magee et al. (1995).*

The palaeoenvironmental conditions under which sediments in the lake were deposited were reconstructed, with the knowledge that various fossil species present in the core are extant and found in specific depositional environments. Ostracods, foraminifera, gastropods and charophytes are particularly useful for the reconstruction of palaeo-salinities given that modern species are typically found within specific salinity ranges. Changes in the relative abundances of the different lacustrine fauna in the Lake Clayton core can therefore be attributed to changes in lake salinity. This in turn can be attributed to variations in water levels in the lake (De Deckker 1982). The fluctuations in water levels and salinities are inferred to have been responses to changes in climate, although how these changes relate to either evaporation or precipitation is impossible to state at present.

Ecological information obtained for microfossils

Ostracods

Ostracods in particular, are sensitive indicators of water salinity (measured in ‰, where sea water is approximately 35 ‰) (De Deckker *et al.* 1982). The following species of ostracod were found in the core:

Reticypris kurdimurka:
As yet, there is little ecological data available on this species (P. De Deckker pers. comm.). It is assumed that this genus indicates a very broad salinity range (4‰ to 172‰) based on the ecological requirements of other *Reticypris* species. *R. kurdimurka* was originally described from the Coward Spring area south of Lake Eyre, and has since been found in Lake Eyre during recent flooding events.

Diacypris dietzi:
This species is generally not common in salt lakes. Although evidence suggests that the species generally can survive salinities from 4‰ to 141‰, a few isolated cases of specimens have been found at 0.34‰ and 216‰ (De Deckker 1982).

Platycypris baueri:
This species has the broadest salinity range of any ostracod found in Australia. Evidence points to the species being able to survive at salinities ranging from 5‰ to 195‰, although the species is much more abundant at salinities above approximately 70‰ (De Deckker 1982).

Foraminifera

The presence of foraminifera in lakes is a phenomenon already recognised by Cann and De Deckker (1981). Foraminifera are generally less sensitive indicators of salinity levels, although they can indicate whether or not a lake was permanently filled. Some species can survive fluctuating salinities and periods of desiccation, whereas others can only be found in permanent waters. They generally prefer salinities and/ or chemistries of lakes that approach that of sea water, as optimum growth and appearance of new generations most often occur at these values. The following species were found:

Ammonia beccarii:
A. beccarii indicates water chemistries similar to sea water, i.e. with sodium (Na) and chloride (Cl) as dominant ions. Although this species can survive a broad range of salinities (from 7‰ to 67 ‰), it grows and reproduces most successfully at salinities between 20 ‰ and 40 ‰ (Cann and De Deckker 1981; De Deckker 1982). *A. beccarii* cannot survive the summer evaporative episodes of saline lakes, requiring permanent water to survive (Cann and De Deckker 1981).

Elphidium crispum:
E. crispum is a species that is representative of ephemeral saline lakes (Cann and De Deckker 1981) as it can survive summer evaporative episodes by providing the numbers necessary for re-establishment in the following winter. The salinity range of this species is as yet unknown, although it is thought to "survive" up to high salinities (De Deckker 1982).

Charophytes
Charophytes are a group of submerged "algae" which are common inhabitants of shallow oligotrophic waters. Parts of their structure may become calcified, the most common of which are the oogonia or female reproductive organs. These are readily preserved as fossils. The following charophyte species was found:

Lamprothamnium papulosum:
This species is noted for its salt water tolerance and is commonly associated with saline lakes in Australia, ranging from relatively fresh to brine sea-water salinities. *L. papulosum* can survive at salinities up to 70‰, although it does not generally successfully germinate or grow above 53‰ (Burne *et al.* 1980). This species can regenerate after considerable periods of desiccation, although it does require a transient period of water cover of suitable salinity for a minimum time (either through a periodic supply of rain water or relatively fresh continentally derived ground water) for germination and growth to take place (Burne *et al.* 1980).

Gastropods
Gastropods are not very sensitive indicators of specific salinity. Their presence however, does indicate whether sediment deposition was under saline conditions. As they are generally shallow water inhabitants (having to graze on algae and plants which grow in shallow water due to their requirement for light to photosynthesize) it must be noted that isolated examples of these gastropods in deep water clays may have been deposited as a result of juvenile gastropod species travelling upside down along the water surface tension. When the gastropods lose contact with the surface tension, they fall through the water column, where they are incorporated in sediments after death (De Deckker pers. comm.). This means that the presence of gastropods can add no further information on the deposition of these sediments. The following species was found:

Coxiellada sp.
This is apparently quite common in central Australia, indicating a saline environment, as it is a halobiont species. It is closely related to the more ubiquitous halobiont *Coxiella.* It can withstand lake desiccation and also survive high salinities (up to 124‰) by sealing its aperture with its operculum (De Deckker 1982). Nevertheless, it cannot survive lakes which remain dry for several years (De Deckker *et al.* 1982). It requires a high frequency of flooding.

Results and Conclusions
The microfossils recovered from the core do not exhibit clear trends, as shown by the species abundance with depth curves that were generated (Figures 3 and 4). Despite this, a broad understanding of some depositional aspects of the lake can be gained and some palaeoenvironmental features can be reconstructed from knowledge of the ecology of different species that are present throughout the core.

The gastropods (found at depths of 14 - 16 cm, 673 - 675 cm, and 711 cm) indicate deposition under saline conditions. This fact is reinforced as they occur with salt tolerant ostracods and charophytes. The charophyte species also indicate saline conditions (up to 70 ‰), although (like the gastropods) they are not present at all depths in the core.

Ammonia beccarii was the only foraminifera found in any significant numbers, and indicates that after a drying phase (as indicated by a weak palaeosol) the lake remained full until the final drying phase as indicated in the core. Poor test formation (small and deformed shells) indicates, however, that the environment was stressful to this taxon. As there was only one poorly formed specimen of *Elphidium crispum*, it is most likely that it was transported into the lake by a bird.

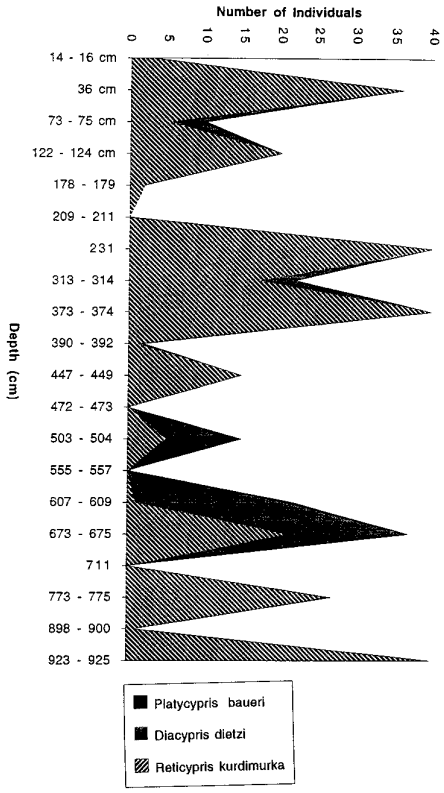

Figure 3: *Species abundance with depth curve for Ostracoda species*

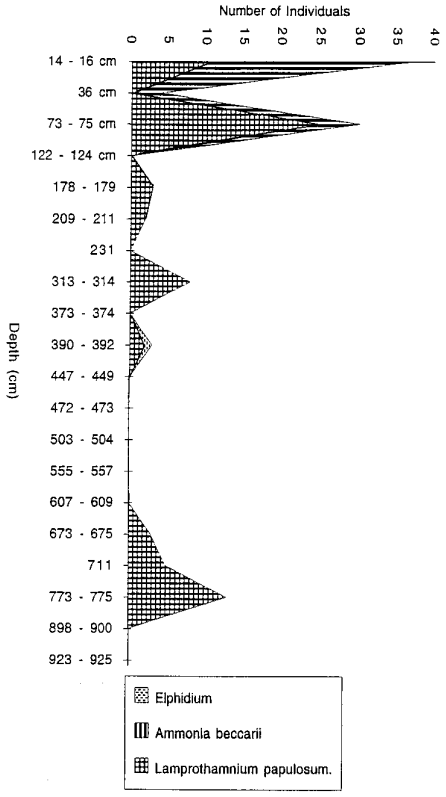

Figure 4: *Species abundance with depth curve for Foraminifera and charophyte species*

The ostracods were the most abundant fauna represented. They also indicate deposition under saline conditions for the entire core. However they only give a broad spectrum of salinities under which different facies may have been deposited, as all the species found have a broad salinity range in which they can survive. Work is presently being carried out to calculate "optimal" salinities for these ostracods (Taylor pers. comm.).

The salinity range in which the fauna and flora were living can be narrowed down given the various combinations of the organisms at different depths in the core. *Ammonia beccarii* and *Lamprothamnium papulosum* have the narrowest salinity ranges. Where these occur the possible salinity range is reduced quite considerably. However, the remaining portions of the core which contain only ostracods show a very broad salinity range under which the sediments may have been deposited.

Conclusions

The possible salinity range under which the Lake Clayton sediments may have been deposited is given in Figure 5. Given that combination of the different flora and fauna throughout the entire length of the core indicate broad salinity ranges, the only obvious fact that can be determined is that the lake remained saline from the first time it flooded over the Etadunna Formation (Miocene dolomitic clay as represented in the bottom of the core) until the latest phase represented in the core. There is a very broad salinity trend which indicates that the bottom of the core was deposited under more saline conditions than the rest of the core. After the higher salinity phase of the lake, there appears to have been a lower salinity phase, which was then followed by a very slight increase and then decrease in salinity towards the top of the core.

The above mentioned results are being refined with more intense sampling during work towards my Honours project. An additional 56 samples have now been taken from the core and these are in the process of being analysed in more detail. The data from Lake Clayton are being correlated and compared with work being undertaken at William's Point (Cliff Section and SLEADS Core 83/6) at Lake Eyre's

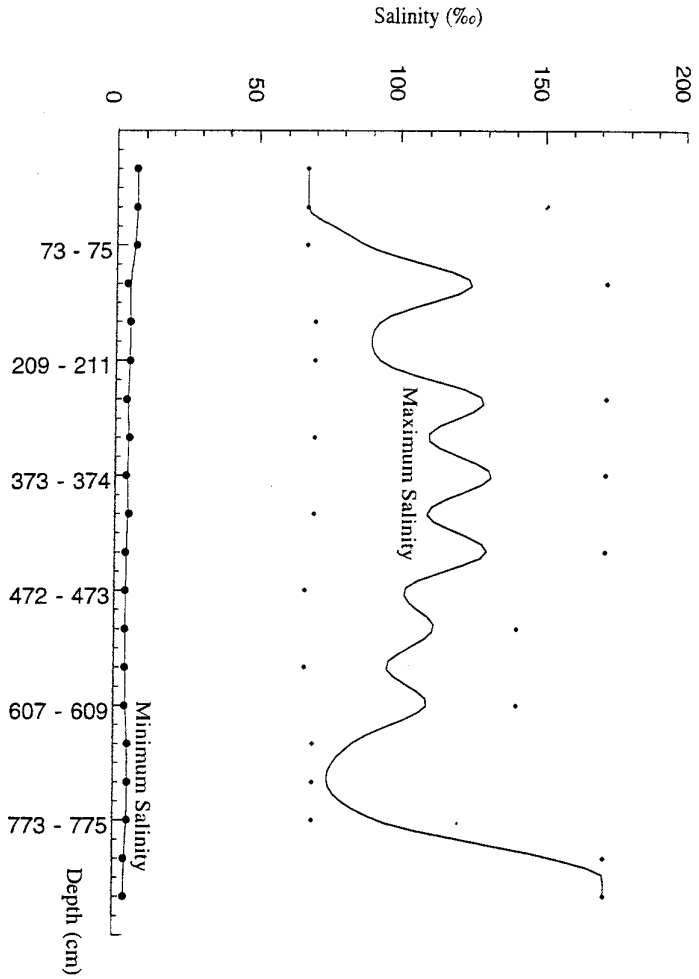

Figure 5: *Postulated approximate salinities under which Lake Clayton sediments were deposited*

Madigan Gulf. It is hoped that a fine tuned picture of water quality changes through

time at these different areas will be obtained, leading to a description of the palaeoenvironments of the southeast Lake Eyre area.

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A modification of the Troels-Smith system of sediment description and portrayal

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Introduction

The adequate description of unconsolidated sediments, particularly those containing a substantial organic component, and their meaningful portrayal in diagrammatic form, is a problem that has been faced, sometimes continuously, by a substantial number of Quaternary researchers and teachers. Some methods emphasise the genesis of deposits as a basis for classification. These systems require a detailed knowledge of botany and palaeoecology and, in most cases, have been developed in other parts of the world, especially north-west Europe (eg. von Post and Granlund 1926), where local knowledge of floras and community types is important. However, their applications to other regions are very limited because of different sediment-forming plants and environmental conditions which lead to very different sediment types. Other methods, developed in the physical sciences, tend to be focused on the size and distribution of the inorganic component of sediments and have very little ability to differentiate organic materials..

Ideally, a system should not assume that the researcher has a strong background in any particular natural science, should be simple enough to encourage its use in any geographical and depositional environment, and should be sufficiently flexible to incorporate the level of detail in description required by the investigator. The approach devised by Troels-Smith (1955) possesses many desirable characteristics and his system or modifications of it (Aaby and Berglund 1986, Birks and Birks 1980) have been the most widely applied in the description of lake and particularly swamp sediments over recent years.

The Troels-Smith system

Troels-Smith (1955) incorporates three major properties into his system; physical properties including the appearance and mechanical qualities of the deposit, humicity which is the degree of decomposition of the organic material present, and components which include the nature and proportion of the elements composing the deposit (see Table 1). For most features a five class scale (0-4) is used for characterisation with 0 denoting the absence of, and 4 the maximum value for, the feature in question. In the case of sediments made up of a number of components, the total value of the individual components must not exceed 4. However, very slight changes in the value of any character can be indicated by the use of plus and minus signs. In the case of undefined components or 'accessory elements' such as shells or artefacts, their abundance can also be accommodated by the five class scale, but outside the sum of defined components. Additional information on specific elements such as insect remains, ostracods, diatoms etc can be provided from microscopic study using a similar five point scale of abundance (ie 0=absent, 1=rare, 2=occasional, 3=frequent, 4-abundant).

The system is also designed to provide a representation of sediments diagrammatically so that a description of a core or sediment column can be placed against a pollen or other palaeoecological diagram or, from a number of core descriptions, a cross section of a deposit can be illustrated. The diagrammatic representation focuses on sediment components with each having a symbol which allows overlap with other symbols in mixed sediments. The density of symbols can also be varied to represent the quantity of each component.

Problems with the system

Despite the comprehensive and generally objective nature of the system and the degree of flexibility offered in terms of the amount of detail desired in description and presentation, I have found, over the last 25 years, a degree of resistance to its use by researchers, particularly students. Statements like 'Troels-Smith's

(1955) method, somewhat simplified, was used to describe the sediments in the field, but more colloquial terms are used in this text' (Shaomeng *et al.* 1986) make me feel that this resistance is more widespread. The statement implies that the system is perhaps too complex and that it may not be understood by readers at least of the *Journal of Biogeography,* within which this article appeared.

Birks and Birks (1980 p.41) consider that the complexity is more apparent than real with their statement that 'Although the Troels-Smith system appears to be complicated at first sight, it is in fact simple and logical to use'. However, it is probably easier, as well as more profitable, for those in northwest Europe to become familiar with the system than those in China, Australia etc. because it reflects more obviously the range and relative importance of sediment types that exist in that region. I can't believe that anyone in this part of the world would be impressed by reading 'An inverted-Y sign is proposed for *Turfa lignosa* originating from *Ericales:* it is visually related to the TI symbol and is part of the symbol often used for *Ericales* in pollen diagrams' (Aaby and Berglund, 1986). There is, of course, no need to go into this degree of detail within the Troels-Smith system: however, all this information needs to be sifted through to ensure its irrelevance.

The last quote highlights not only that the system contains a parochial component, probably not even realised at the time of its formulation, but also that it adopts a terminology which is inappropriate in a country like Australia which is intent on disbanding its university classics departments. It is difficult enough to demonstrate to students the importance of using the Linnean system for plants and animals without introducing a latinised binomial system for sediments as well.

A final consideration is the stratigraphic representation of sediments. There is a large variety of symbols but not all need to be used. Of greater concern is difficulty in deciphering some symbols when the density of one or more of them is high, and in interpreting the diagram correctly from the visual impression created. For example, it is difficult to incorporate minor components into a fresh *Sphagnum* moss deposit and the high density of the moss symbol gives the impression more of a condensed humified peat than a fresh one.

The modified version

The proposed system is outlined on Table 1. It adopts essentially the same structure as that of Troels-Smith but has dispensed with latinised terms for characteristics. The change in terms has proved no problem for physical features and humicity as English terms were already available. There is, however, a regrettable loss of structure to the classification of component parts by elimination of the binomial system. The categories *Turfa* and *Limus* in particular were useful generic terms for essentially 'whole plants' and lake deposits respectively which are difficult to replace without inventing, or utilising other, unfamiliar terms. *Detritus* has been retained because of its general usage. There are no regrets about dispensing with the terms *Argilla* and *Grana* for inorganic components. One new component, charcoal, has been added because of its importance in many Australian sequences and because, at a macroscopic scale, it is derived from local communities and provides some indication of the nature of vegetation succession. There is no subdivision of organic sediment components, thereby eliminating components which are frequently defined by specific plant types some of which have restricted geographical ranges.

Probably the greatest problem in allocating components is determination of the difference between woody plants and woody detritus and between herbs and herb detritus. I find it useful to restrict the terms woody plants and herbs to plant material which clearly penetrates deposits, indicating original growth position. The identification of these components then becomes important for detection of contamination of sediment by younger roots.

Some indication of the operation of the system is provided by the hypothetical example shown on Table 2 and on Figure 1. It is designed to indicate the kind of succession which is characteristic of basin infilling since the last glacial period except that the degree of variation has been exaggerated to allow inclusion of all defined sediment components. It may be noted that one major character, humicity, has been excluded. This is because the degree of humification can be illustrated by representation of the amount of humus present in peat and detrital sediments. However, the difficulty of separating humified macroscopic plant remains and organic lake muds, both of which can squeeze through the fingers, remains.

The proforma, designed for sediment description in the field but which can also be used in

Table 1: Characteristics of the modified Troels-Smith system of sediment description with original terms in brackets

Physical Features	
Degree of darkness	Varies from 0 in the lightest occurring shades (eg. clear (Nigror) quartz sand and lake marl), through 1 (eg. calcareous clay), 2 (eg.fresh swamp peat), 3 (eg. partly humified peat) to 4 in the darkest sediments (eg. completely disintegrated peat).
Degree of stratification	Visual or structural horizontal banding or layering. Varies (Stratification) from 0 where the deposit is completely homogeneous or breaks in all directions, to 4 which consists of clear thin layers or bands.
Degree of elasticity	The sediment's ability to regain its shape after being (Elasticitas) squeezed or bent. Varies from 0 in plastic clay, sand, disintegrated peat etc. to 4 in fresh peat.
Degree of dryness	Deposits fall between 0 (clear water) and 4 (air dry material). (Siccitas)1 indicates very wet runny sediment such as surface lake muds, 2 represents saturated sediments, the normal condition below the water table, while sicc. 3 indicates moist, unsaturated sediments.
Colour	Best determined by reference to Munsell soil colour charts. Changes in colour with exposure to air should be noted.
Structure	The dominant structural feature (eg. fibrous, homogeneous)
Sharpness of boundary	The boundary can be diffuse (> 1cm: lim. 0), very gradual (Limes superior)(<1cm to > 2mm: lim. 1), gradual (< 2mm to >1mm: lim. 2), sharp (<1mm to > 0.5mm) or very sharp (< 0.5mm).
Humicity The degree of humification or disintegration of organic (Humicitas) substances. It is measured by determination of the nature and amount of material passing through the fingers on squeezing; 0 (fresh peat yielding clear water), 1 (slightly decomposed peat yielding dark coloured, turbid water), 2 (decomposed peat yielding half its mass), 3 (very decomposed peat yielding three-quarters of its mass) and 4 (totally decomposed peat yielding almost all its mass).	
Components	
Mosses *(Turfa bryophytica)*	*Sphagnum* is the most common peat-former.
Woody plants *(Turfa lignosa)*	Roots of trees and shrubs together with attached stumps and branches, frequently in growth position.
Herbs *(Turfa herbacea)*	Roots of herbaceous plants together with attached stems and leaves, frequently in growth position.
Woody detritus *(Detritus lignosus)*	Fragments of woody plants >2mm.
Herb detritus *(Detritus herbosus)*	Fragments of herbaceous plants >2mm.
Fine detritus *(Detritus granosus)*	Fragments of woody or herbaceous plants <2mm.
Charcoal	Carbonised fragments of predominantly woody plants.
Organic lake mud	Homogeneous organic lake sediment composed of remains (*Limus detrituosus)* of microplankton and humified remains of macrophytes.
Humus *(Substantia humosa)*	Completely disintegrated organic substances and precipitated humic acids.
Organosilicates *(Limus siliceous)*	Siliceous skeletons or skeleton fragments of diatoms, sponges etc.
Carbonates *(Limus calcareus)*	Calcium carbonate or marl. Similar in colour and texture to *L. siliceous* but soluble in hydrochloric acid.
Iron oxides *(Limus ferrugineus)*	Iron oxides of various types and colours.
Clay (*Argilla steatodes)*	Mineral particles <0.002mm
Silt (*Argilla granosa)*	Mineral particles 0.002-0.06mm
Sand (*Grana minora)*	Mineral particles 0.06 - 2mm.
Gravel (*Grana majora)*	Mineral particles >2mm.

Table 2: An example of a field description sheet for sediment

the laboratory, is structured in a similar way to that which I originally used some 30 years ago at the Australian National University. Apart from name changes, the only modification is the inclusion of space for accessory elements which, in this example, includes shells.

The stratigraphic column on Figure 1 is constructed in the Troels-Smith manner except that a measure of the degree of sharpness of the boundaries is included and there is no variation in the density of symbols to indicate the relative importance of major components. To encourage the use of the system, all symbols are available in TILIAGRAPH within Eric Grimm's computer package TILIA2.

In place of symbol density, proportions are indicated here by graphing individually the values of various components, a method introduced by Shaomeng *et al.* (1986). This system allows for minor components to be shown and for other characteristics to be displayed in a similar manner. Additional data may be added from more detailed, microscopic examination of the sediments. It is often convenient to determine the nature and abundance of accessory elements of interest from low powered microscopic examination of sieved material resulting from preparation of samples for detailed palaeoecological analysis. In the example shown, abundance measures are considered to have been estimated from the greater than 100 micron fraction discarded in the preparation of pollen samples at 10cm intervals along the core. The macro-charcoal values provide a more detailed estimate of local fires than the charcoal component while the detailed ostracod values have replaced the shell determinations made in the field. If desired, grain size analysis of the inorganic sediment components could be undertaken to refine or augment the inorganic component measures of silt and clay, sand and gravel. Conversely, only the stratigraphic column, or only selected individual characters, need be illustrated if the data are to be graphed alongside the results of detailed microscopic examination of pollen, diatoms, etc.

Discussion

A brief examination of the Australian literature incorporating stratigraphic description, particularly in association with pollen studies, indicates that there is little consistency in terminology or in the representation of sediment types diagrammatically. This inhibits easy comparison between sites and the establishment of a general picture of sedimentary deposits which could lead to a better understanding of them. In a recent study of peatlands in Victoria (Kershaw *et al.* 1993) we had to abandon the use of detailed sediment stratigraphy as a basis for site evaluation or for the construction of a classification of sedimentary environments because of comparison difficulties, and relied instead on pollen indicators for characterisation of site conditions.

Comparative studies are becoming more important as solutions to general environmental problems are sought and as regional and global patterns of change are investigated for validation of atmospheric general circulation models. The widespread adoption of TILIA is providing the necessary consistency for construction and interrogation of regional and global pollen data bases. Unfortunately this is not yet happening with sediment stratigraphy although the inclusion of Troels-Smith symbols in TILIA2 is a step in the right direction. The system outlined here may be viewed as yet another classification to further complicate the picture but, for data base purposes, it is very compatible with the widely adopted, original Troels-Smith system, and if simplification encourages use then the benefits may be substantial.

Whether this proposed system is the most useful for Australian deposits is open to question, and discussion in *Quaternary Australasia* is encouraged. There does appear to be some emphasis on colour in Australian stratigraphical descriptions and portrayal which is not emphasised in the Troels-Smith system, possibly because northwest European deposits are more predictable or less colourful than those in Australia or, more likely, colour is a difficult feature to represent diagrammatically. There will be little problem in superimposing colour on stratigraphic profiles, regardless of the classification, in the future if the trend towards acceptance of coloured illustrations in journals and books continues.

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Figure 1: Graphical portrayal of characteristics of the modified Troels-Smith system

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