Quaternary Australasia

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Material for the next issue should reach the editor by **30th September 1996**:

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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 Bill Boyd, with assistance from Colin Murray-Wallace. The annual subscription is $A20 or $10 for students, unemployed or retired persons. President is Dr Ian Thomas, Department of Geography, University of Melbourne. An application form for membership is appended to this issue (last page), and should be returned to Dr Geoff Hope, Membership Secretary, Division of Archaeology and Natural History, Research School of Pacific and Asian Studies, Australian National University, Canberra, 0200. Members joining after September gain membership for the following year. Existing members will be sent a reminder in December.

COMMITTEE MEMBERS

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EDITORIAL

It is with pleasure that I put this issue to bed (as they say in the newspaper trade). Fortunately I only have to do it twice a year. We have a good selection of papers this time; many thanks to both the contributors. of papersand of miscellaneous bits of information in other sections.

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The very next item in this issue advertises the forthcoming AQUA General Meeting and Field Trip. October will see as many AQUA members as possible making their cheery way to lovely S.W. Victoria, to indulge in an orgy of Mad Quaternarist Disease. I encourage every member to get there. There is nothing like an AQUA Field Meeting ... except another AQUA Field Meeting. For all those research-weary postgrads, what better way to get re-enthused? And for all of those isolated Quaternarists in out-of-the-way Universities and Other Places (you can decide if your institute qualifies), here's you opportunity to see the faces behind the email messages and publications.

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Now, having encouraged you all to get to the Field meeting, I must say that I will not be there. I give my apologies. My excuse is that I will be struggling through autumn in Cambridge, where I will be writing papers and reports from my work in P.N.G. and Thailand. In the meantime, let's return to my not-so-secret Editorial agenda. It would be most desirable to publish, in the next issue of *QA*, all the papers presented at the forthcoming AQUA General Meeting, either in full or as abstracts. I encourage everyone presenting a paper to bring a copy of the paper or the abstract to the meeting. Give them to someone reliable (i.e. anyone on the Committee) to pass on to me (or the acting editor ... see below). Also, if any field trip notes are prepared, it would be great to publish these in the issue. So get those pens and word processors out and get busy. And by the way, don't feel that you have to present a paper at the Meeting to get it published in our eminent journal. Remember the old adage: Publish or Perish! This refers to the journal as much as the authors.

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At the General Meeting, I presume there will be the usual games of Let's-Look-At-The Floor-Or-The-Ceiling and Now's-The-Time-To-Go-To-The-Bar/Toilet, while the Old Committee try to recruit members to the New Committee. When the job of *QA* Editor comes up do not feel shy to volunteer. The job is most rewarding , especially when you see the final product running off the press. However, if there really is no-one who wants the joy and experience that comes with the job, I am willing to continue. The job has also been well-supported over the years by Colin Murray-Wallace who has, time after time, taken the pressure of me by "doing" the printing and mail out. I hope that support will continue.

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Now, assuming that there is no change to the Editor (a bit of an assumption I know), I have taken the preliminary step of asking Maria Cotter, one of my post graduates and sometime research assistant, to act as Editor for issue 14/2 (December 1996). My previous experience of trying to edit *QA in absentia*. warned my off trying it again. I presume that no-one has any objection to Maria doing this job, but have asked President Ian to put it to the General Meeting. Maria is willing to do the job, and will be in touch with me during the process. She will also have access to my computer, so all email messages and electronic transfer of copy will be directly available to her. She has had some experience, in that she has helped me in the past with compiling *QA*, by typing up bits and proof-reading drafts (for which I am, of course, always grateful).

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That's all folks!

Bill Boyd,
Editor

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AQUA

NOTICE OF GENERAL MEETING

NOTICE OF AQUA GENERAL MEETING & FIELD TRIP

3-6 October 1996

Apollo Bay, SW coast of Victoria

It's time for all Quaternarists to gather and discuss the business of AQUA. The meeting will consist of field trips, a general meeting, and a single friendly session in which students and others can present short papers detailing their recent work. Up-to-date information regarding the CLIMANZ and PASH groups will be presented. Any item of interest to Quaternarists will be entertained.

The only time when the President, Membership Secretary and Treasurer can attend is between 30th September and 6th October. On that basis the meeting will run from Thursday 3rd October to Sunday 6th October.

The meeting will take place somewhere near Apollo Bay on the southwest coast of Victoria. A formal general meeting will be held on the night of Friday 4th. Elections will be held, with nominations accepted up to the start of the meeting. Traditions, including awards for the best student presentation and a prize for the most unsupported or outrageous statement will be continued.

During the course of the meeting we can see for ourselves the study area which has made Peter Kershaw a local legend, Bernie Joyce a hero and Leslie Head a prophet. Crater Lakes, coastal landforms, lava tubes, volcanoes and mires of all kinds are there for our inspection. Excursions to these and other places of interest will run each day. Minibuses will be available, although private cars will probably also prove useful.

Final details of the venue will be posted to members as soon as possible. We aim to have both camping and cheap alternative accommodation available.

Members who want to present a paper should send an abstract of no more than a single A4 page to either Geoff Hope or Kate Harle. All papers and abstracts will be published in the next issue of *Quaternary Australasia*, so hard copy and disc should be brought to the Meeting. Alternatively, copy can be mailed to the Editor at bboyd@scu.edu.au

It is also hoped that the Field Meeting notes will be published in the next issue of *QA*, perhaps starting a long and magnificent tradition!

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AQUA
TREASURER'S REPORT

TREASURER'S REPORT FOR 1995

This is my first report and I apologise for my tardiness in its preparation. 1995 has been an interesting year as Treasurer, one in which I have learned the hard way about balancing the pluses and minuses and have learned about the benefits of income tax exemption.

AQUA has made a small profit in 1995. Income from subscriptions has been slightly higher than in 1994. Income from investments has been low again due to the time taken to transfer funds to Melbourne and investment decisions being made. Also, the interest earned on these investments has attracted government withholding tax of $285.30. The tax exemption status of AQUA was not appreciated by me. This situation has been rectified and the tax paid will be claimed during 1996.

Receipts were much higher with $400 going to the Biodiversity Council of Australia and $500 to help with costs for the conference "Climate Change: Retrospect and Prospect" at the University of Melbourne in November 1995. Printing costs for the journal *Quaternary Australasia* were considerably higher than in 1994. These costs do represent the yearly cost to produce *Quaternary Australasia* as the cost for volume 13/2 which will be paid in 1996 is similar to that of volume 12/2.

The Association is in a secure financial situation with prospects for a successful 1996.

Yours sincerely,

Christine Kenyon
Treasurer of AQUA

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Statement of receipts and payments from 3 December 1994 to 31 December 1995

Uncommitted balance brought forward from 1994		25,564.35 CR
Add receipts		
Personal subscriptions		
1995 $20	2,722.08	
1995 $10	575.00	
1996 $20	80.00	
1996 $10	30.00	
Institutional subs		
1995	449.48	
1996	60.00	
Commonwealth Bank, Bank Melbourne interest	838.19	
Nerriga conference	235.40	

	5,074.15	
Deduct payments		
Printing costs	2,087.90	
Postage costs	1,407.95	
Dept. Geography, Univ. Melbourne (stationary)	47.00	
Bank & Govt charges	38.96	
Biodiversity Council support	420.00	
Climate Change Conference, Univ. Melbourne, Nov. 1995	500.00	
Govt withholding tax	285.30	

	4,778.11	
Excess receipts over payments	296.57 CR	
Uncommitted balance, end of 1995		25,860.92 CR
Investments		
Bank of Melbourne 2/5/1995 for 1 month @ 5.6%	5,000.00	
Withdrawal Dec. 1995	3,000.00	
Deposited in C'wealth Bank account for printing expenses yet to be expended. The balance and accrued interest reinvested with Bank Melbourne; see below)		
1 month @ 5.25%	2,084.53	
12 months @8.6%	10,000.00	
6 months @ 8.1%	10,000.00	
Commonwealth Bank balance as at 31/12/95	3,413.09 CR	
TOTAL ASSETS		25,860.92 CR

COMMENT

BASIN LAKES QUARRY LOSES APPEAL

It wasn't particularly appealing in the first place! Anyway, it is with pleasure that I can announce that the Victorian Tribunal rejected an appeal by proponents to dig a 20m deep quarry into the crater rim between East and West Basin Lakes near Colac (pictured on the front cover).

Sue White and Peter Gell represented the Geological Society of Australian at the hearing, at which written submissions from Drs Ian Bayly, Bill Birch, Pat De Deckker, Bernie Joyce and Ian Thomas (on behalf of AQUA) were read out or tabled. The petition signed by 35 participants at the "Climate Change: Retrospect and Prospect" conference of November 1995 was also presented.

The appeal was rejected on the grounds of intrusion on visual amenity, incompatibility with surrounding land uses, and that it would:

> **detrimentally affect the scientific amenity of the Basin Lakes and the immediately surrounding land by virtue of diminished value for future geomorphological, limnological and palaeolimnological scientific studies.**

A pat on the back to all those who took up the challenge, especially Roger Jones. There is a line in there somewhere about swimming against the tide which I won't include as the full meaning might be lost to some from States with more enlightened administrations.

Peter Gell

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DEPARTMENTAL NEWS

AUSTRALIAN NATIONAL UNIVERSITY

John Chappell will be Convenor of the Division of Archaeology and Natural History from mid-April.

Bob Wasson will start as Professor of Geography, the Faculties, in June 1996.

POLLEN LABORATORY AND THE SOUTH WEST PACIFIC POLLEN ATLAS CONSUMED BY FIRE

Intrepid Reporter

While staff were attending the first day of the CLIMANZ meeting in the Geology Department of the Australian National University on 26th February, big trouble was brewing in the pollen preparation laboratory of the Division of Archaeology and Natural History. A plastic container of tertiary butyl alcohol (TBA) was left to warm for a brief period on a hot plate in a new fume cupboard in the laboratory. TBA crystallises at what Canberrians laughingly call room temperature, so the aim was to bring it to a liquid state, but unfortunately the vapour phase was achieved and flashpoint once the container melted. The fire rapidly spread to the fume cupboard which proved to be pretty good at burning itself. Soon an impenetrable cloud of acrid black smoke poured from the windows and through doors into the main microscope lab where the fabulous ANU slide collection and the computers used to record the electronic pollen atlas reside along with a brand new Zeiss Axiophot. Staff were absent at lunch but at last the fire was noticed and the area searched by fire wardens before a full evacuation. Fears were raised that HF and other poisons might be present, or that the radiation sources in the adjacent state-of-the-art OSL dating lab might be involved. The fire brigade was contacted and acknowledged that it had had an automatic alarm, but that those things are always going off, so they ignore them. But they got quite interested when the toxic nature of the fire was realised. CLIMANZ attendees arrived to find four fire engines, breathing apparatus and special foams being used while Economists and International Relations specialists milled aimlessly about.

As it turned out, the fire had burnt into the ceiling and melted a joint on water pipes and put itself out. All ingress was banned for a day or so, and then the clean up started. Everything was coated in a film of sticky carbon, with a pH of 2.5 and there was a vile smell that has lingered for a month. The Occupational Health team decided there was no danger, having been given the building back by the firepersons, but this hasn't been the experience of the clean up teams and staff, many of whom have acquired asthma-like symptoms or shooting muscular pains. Atholl Anderson, Gillian Atkins, Eugene Wallensky, Carlo Martiniello, Dan Marges, Dominique O'Dea and Norman Hill took on the salvage of equipment, and finished each day looking like coal miners. All have reported some symptoms from the fumes, although chemical respirators were used. All the computers and four of the microscopes have been written off, the automated charcoal counter wrecked, the OSL lab partially destroyed, some lab data lost and the working library ruined. Boris, the patient carp who has lived in the lab for 7 years succumbed to toxins two days after the fire but his new companion of a few weeks, Yeltsin, is still alive. Virtually nothing in the pollen preparation room could be recovered, although some samples waiting for preparation miraculously survived.

On the plus side, almost no data is thought to have been lost as the Atlas (which has reached families starting with "S") was stored on 270Mb removable drives that were still copyable. The $85,000 Axiophot can be cleaned and we had two other photomicroscopes elsewhere in the building. The slide collection and vials are OK and the photo card collection has been laboriously cleaned.

Curiously, the computers were insured so we look like getting these back as upgraded models. The laboratory has been reconstructed and repainted but replacing other equipment will take some time or may not be feasible due to lack of dough (the ANU was never what it was rumoured to be; now it is simply broke, but rich in administrators). A more fire-proof repository for the pollen collection is being developed as part of improving the safety and security of the laboratory. Audible smoke and heat alarms are snaking their way into every cranny.

Without the lucky chance of a melting water pipe, the fire could have gained a hold in the ceiling, released the HF and chemical store a metre from the blaze, and completely destroyed a three million dollar pollen and dating facility (and possibly more), including an almost irreplaceable archive. So remember to backup, store duplicates off site and think safety around your own Quaternary facilities.

INTERNATIONAL GEOLOGICAL CORRELATION PROGRAMS

IGCP 396
THE RECORD OF THE QUATERNARY ON CONTINENTAL SHELVES: INTERPRETATION, CORRELATION AND APPLICATION

Announcement of First Annual Meeting, Sydney, Australia, 1 - 3 November 1996

Theme: Continental Shelves - Key sites for Science and Mankind

The continental shelves of the world define a fundamental paradox in our understanding of marine environments. We know more about the deep ocean than we do about the continental shelves. Yet the shelves are most utilised by humankind. IGCP 396 is intended to begin redressing this paradox. Its main objective is to study and interpret the Quaternary sequences on continental shelves so as to permit global correlation of sea-level and climate changes and to identity beneficial multipurpose uses.

All interested scientists are encouraged to attend the first annual meeting of IGCP 396. The agenda for the meeting will include:
1. Election of Officers.
2. Scientific papers
- Quaternary shelf sequences from key areas
- Carbonates on continental shelves
- Shelves as repositories for pollutants
- Shelf hydrodynamic processes
- Other Quaternary processes including soil development
- Dating methods
- Properties and applications of shelf sediments
- Equipment and innovative methods for future exploration

3. Workshops to examine cores obtained from the Australian continental shelf.
4. If time permits, examination of the construction of the Portable Remote Operated Drill, which is intended for operation in 1997 and capable of 100m penetration in water depths down to 2,000m.

For further detail, contact:

Professor Peter J. Davies
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AUSTRALIA

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IGCP 367
LATE QUATERNARY COASTAL RECORDS OF RAPID CHANGE: APPLICATION TO PRESENT AND FUTURE CONDITIONS

Tidal amplitude change working group.

The tidal working group was set up as a result of papers given at the International Meetings of IGCP 367 which indicated a need for greater understanding of the tidal contribution to the sea-level change record.

Aims and objectives of the tidal working group:

- Establish a bibliographic database comprising both direct studies of tidal changes and others where information on tidal heights has been obtained (indirectly) as a result of research. The timescale for this database will be as defined by the IGCP 367 project title.
- Obtain a reference list of indicators of tidal levels from geomorphological, sedimentological, biological, archaeological etc. data. It is intended that this should be published as a final report of IGCP 367.
- Following from the bibliographic database, information on tidal height changes will also be synthesised on a regional basis, where sufficient data are available, to obtain a picture of tidal development with coastal changes in each area.
- Where tidal changes of varying magnitude and/or direction are identified by employment of different methods (e.g. stratigraphic versus modelling), the causes of these differences will be examined in order to (a) improve techniques and (b) obtain an accurate record of tidal changes.
- A list of those with an interest in the field, including postal addresses, contact phone and fax numbers and e-mail addresses, together with information on the techniques employed by workers in the field and the geographical areas in which they

are carrying out research, will also be compiled.

Although the list above represents the primary aims of the working group, anyone with an interest in the topic (whether actively involved in research on tidal changes or not) is encouraged to contact the group leader, preferably by e-mail.

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For further information about the IGCP 367 project in general please contact:

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IGCP 379
KARST PROCESSES AND THE CARBON CYCLE (1995-1999)

Goal and Objectives

- To assess the contribution of carbonate rocks to the content of CO_2 in atmosphere through karst processes, especially dissolution and precipitation, this aspect of the global carbon cycle has been little studied to date.
- To compare the annual balance of CO_2 between the atmosphere and karst system under different geological, climatic and ecological environments.
- To determine the origin and amount of annual emission of CO_2 into the atmosphere from karst areas with geothermal, volcanic activities or active fault, especially those near plate margins.
- Providing information about the processes of environmental change after the late Pleistocene in major karst regions of the world, especially those without other paleoenvironmental information (such as ice cores, lacustrine deposits or eolian deposits).

Research Emphases

- Focus 1. Comparison of on-going karst processes based on *in-situ* monitoring, in an attempt to find out the role of modern karst processes play in global carbon cycle.
- Focus 2. The role which karst processes may play in global greenhouse gas budget.
- Focus 3. To get high resolution karst records for paleoclimate reconstruction with all the available new techniques for selected transect of the world.

Project Implementation

The project is a successor of IGCP 299 "Geology, Climate, Hydrology and Karst Formation" (1990-1994). It was accepted by the UNESCO/IUGS IGCP Board in Paris early February as an on-going project of 1995-1999. The works of the project in 1995 was as follows.

Workshops to prepare a detailed plan, including selection of correlation sites for estimating CO_2 sink by carbonate rock dissolution; CO_2 source by disintegration of carbonate rock under geothermal action or from the mantle; and key sites for reconstructing environmental change after the late Pleistocene with high resolution, where information other than karst records is not available. The workshop standardised the research methodology, including techniques to detect carbon cycling in karst processes, to distinguish mantle carbon from epigenic carbon, to estimate sources and sinks of CO_2 from karst processes, and to reconstruct environmental change with high resolution from karst records, especially techniques of dating young karst sediments. A working group inauguration meeting held in Turkey, September, 1995, with a field seminar on CO2 sources from geothermal karst. Prof. Yuan Daoxian was elected as leader of the project.

International Participation

The project is supported by many karst-related international academic organisation, including the karst commission of International Association of Hydrogeologists (IAH), the karst commission of International Geographic Union (IGU), and the Union of International Speleology (UIS). More than 250 colleagues from 46 countries were involved in the previous project (IGCP 299). The successor one is expecting the same participancy. Links with some IGBP core projects, such as PAGES have been established under the promotion of the new direction of IGCP (Geoscience in the service of society) put forward in 1994. Co-operation with INQUA Paleocarbon Commission has also been established.

At this initial stage of IGCP 379, suggestion and contributions in the following issues will be very much appreciated.
(1) Correlation, monitoring sites for the four objects of the Project.
(2) Standardisation of research methodology, such as techniques to detect CO2, monitoring carbon cycle, and dating young karst sediments.
(3) Place of international working group meetings in the next 5 years.
(4) Papers reflecting the results of your previous and on-going works related to the general aims of the Project. Your suggestion, papers and question will appear on the first issue of IGCP 379 Newsletter.

For further information, contact:

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INQUA PALAEOCLIMATE COMMISSION

WORKING GROUP: SEARCHING FOR VEGETATION SUCCESS-IONS AT THE SCALE OF THE MILANKOVITCH CYCLES IN BETWEEN 2.6 AND 0.9 MA

Leaders: Dr. Suzanne A. G. Leroy and Dr. Cesare Ravazzi

A few sites only have allowed to demonstrate the climate forcing on vegetation during the Late Pliocene-Early Pleistocene (period referred hereafter as Plio-Pleistocene) via the astronomical cycles. Some of these sites are Nogaret, S. France, Vrica, S. Italy, and ODP 658, off NW Africa. In continental sections, true vegetation successions, similar to the one at the beginning of the last interglacial and of our present interglacial in Western Europe can be observed. In marine sites, pollen percentages peak successions are however reflecting a combination of transport modes and vegetation changes. Too many Plio-Pleistocene sites have been studied at a low time resolution obliterating the pollen percentage changes more or less caused directly by vegetation successions induced by astronomical forcing. It is suggested that it is the case for the sites from The Netherlands, where moreover no continuous sedimentary sequences were available for investigations. The palynostratigraphy from the Netherlands widely used in Europe is built up from several disconnected marine and continental sections. Other sites (such as Lieth, Germany) have demonstrated the vegetation successions but were interpreted as long glacial or interglacial phases because no time control was available and because the interpretation of the changes was influenced by The Netherlands palynostratigraphy. In Europe in contrast to the other continents, during the last millions of years, the flora has greatly changed due to the progressive loss of some elements, not always the most thermophilous ones. Several Plio-Pleistocene pollen diagrams have been used to support a biostratigraphy that relies on the progressive disappearance of those "Tertiary relict plants" supposing synchronous disappearances all through Europe. This progressive floral evolution in a one-way direction conflicts with cyclostratigraphy. Even, the absence of any observed vegetation successions has received an explanation. It has been interpreted as proximity of refugia. We know now that the refugia were far from most European sites. These examples from Europe are typical of an evolution in the ideas that has been similar on other continents.

The astronomical forcing on the vegetation has been overlooked for several reasons, mainly a lack of sedimentation rate estimates because lack of good dating possibilitie. Secondly a sampling interval too broad because influenced by methods used in Tertiary studies where no rapid climate changes were expected, instead of by the modern approach (itself strongly influenced by the Holocene studies: high time resolution and botanical approaches) and thirdly a mindset framed by ancient palynostratigraphies such as the widely used one of The Netherlands. Basically we wish the community to open new eyes at the interpretation of the Plio-Pleistocene sections using the cyclostratigraphy, especially the continental ones where it is less easy to obtain isotopic stratigraphy. The final result will contribute to form the base of a strong cyclopalynostratigraphy, and throw new lights on palaeoclimates at the down of the Quaternary.

1. We propose to compare the vegetation development at a global scale during the same isotopic stages. We suggest therefore to use relatively easy to date time slots, such as the magnetic reversals: Gauss/Matuyama, and the base and top of Olduvai. Because the astronomic forcing is not the same at all latitudes, it is important to compare sites from different latitudinal bands and different hemispheres. If comparison of the same cycles can be made, past general circulation patterns could then be reconstructed in the same way as COHMAP and PRISM for example. Based on the few sites demonstrating the reality of the astronomical forcing, a new mindset is promoted here that we recommend to use until new progresses are made.

2. We wish to establish a network of scientists (palynologists for pollen and spores and palaeobotanists for fruits, leaves, and other macroplant remains) sensitive to the issue, and who are commonly using the concept of cyclopalynostratigraphy. We wish to encourage the revision of old interpretations or even the resampling of some well known sites. The example of Vrica is very illustrative. N. Combourieu-Nebout has published the results of a widely spaced sampling on the whole section in 1987. It gave broad changes that have been correlated to The Netherlands palynostratigraphy. Later on, she studied with a higher resolution a subsection of Vrica and could evidence the forcing by the obliquity on the vegetation changes. Also the example of Leffe, Italy, is demonstrative. An improvement similar to the one of Vrica has been realised at Leffe, Italy. Lona produced an excellent pollen record in the fifties. He found several vegetation changes correlated to the older terms of the glacial chronology of the Alps. The new pollen record allowed to recognise a more detailed succession of climate cycles, which show the durations and amplitudes similar to those characterising the obliquity cycles. The two studies resulted in two different duration estimates of the whole sequence. The first duration estimation was of 1.5 Ma and the second, of less than 0.5 Ma. At Stirone (N. Apennines, Italy) there are three pollen diagrams, published only in a preliminary/synthetic form, but until recently no good stratigraphic control was available. Indeed Channell *et al.* and Mary *et al.* have now provided a palaeomagnetic time frame revealing that the sequence has a high sedimentation rate and contains some important lacuna.

3. Few sites have micro and macroflora fossils associated eg. Leffe and S.Barbara in Italy and Bernasso in France. It allows a higher level of determination for the microflora, a better spatial reconstruction for the macroflora ones and a better interpretation of climate requirements of fossil taxa.

4. The Holocene approach is moving down the geological time scale. It is recommended to use a scale of study that is able to detect changes at a societal scale for the Plio-Pleistocene sediments. Therefore the research becomes more relevant to understand the environment of past and present human. The new studies should ensure that the sampling is done with a high resolution approach, as high as the very limit of bioturbation. It can reach even 1 cm or less in continental sections at some interesting levels.

A confirmation or rejection of the van der Hammen scheme of temperature and precipitation changes during a glacial-interglacial cycle: lag of precipitation on temperature, making dry and warm beginnings of interglacial periods and cool and wet ends of interglacials, might be one of the outcomes of this working group.

It would be interesting to check this hypothesis outside of Europe and make the links with the position of the Earth and the Sun.

This project has no stratigraphic aims *per se.* However, this new philosophy in the study of Plio-Pleistocene sediments will produce results that can be used by stratigraphers and INQUA-SEQS Commission. We especially hope to lead them to integrate the cyclostratigraphy, and even higher resolution studies in the choice produce results that can be used by stratigraphers and INQUA-SEQS of their boundaries. Inter-site correlation will undoubtedly gain in accuracy.

For further information, including a list of relevant references, contact:

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CONFERENCE AND MEETING NEWS

22-29 June 1996. **Ninth International Palynological Congress**, Houston, Texas, U.S.A. Contact: D.J. Nichols, U.S. Geological Survey, MS 919, Box 25046, Denver, Colorado 80225-0046, USA. Phone: 303-236-5677; FAX: 303-236-5690; e-mail: dnichols@greenwood. cr.usgs.gov

1 - 5 July 1996. **12th Australian Institute of Physics Congress incorporating the 16th AINSE Nuclear & Particle Physics Conference**, Hobart. Australia. Contact: Roger Gammon, AINSE, Private Mail Bag 1, Menai, N.S.W. 2234, Australia. Phone: (02) 717 3376; FAX: (02) 717 9268.

21 - 23 July 1996. **First Regional Conference on Climatic Change**, Tehran, Iran. Contact: First Regional Conference on Climatic Change '96 Secretariat, Islamic Republic of Iran meteorological Organization, P.O. Box 13185-461, Tehran, Iran. Fax: 021 6469044.

23 -27 July. **1996 Western Pacific Geophysical Meeting**, Brisbane, Australia. Contact: Jozef Syktus, Division of Atmospheric Research, CSIRO, Private Bag No. 1, Mordialloc 3195, Australia. Fax: (03) 92398 4444.

31 July - 6 August 1996. **The Western Pacific, 5000 to 2000 BP: Colonisations and Transformations**, Port Vila, Vanuatu. Contact: Dr Mathew Spriggs, Archaeology and Natural History, RSPAS, ANU Canberra 0200 (Fax 06 2494917; e-mail: spriggs@coombs.anu. edu.au)

1-4 August 1996. **Climatic Change - The Karst Record**, Bergen, Norway. Contact: Dr. S. E. Lauritzen, Department of Geology, Bergen University, Allegaten 41, N-5007 Bergen, Norway; Phone: (47) 55-32 08 95; Fax: (47) 55 32 44 16; e-mail: Stein.Lauritzen@geol.uib.no

4-14 August 1996. **30th International Geological Congress**, Beijing, China.

5-10 August 1996. **28th International Geographic Congress: Land, Sea and Human Effort**, The Hague, The Netherlands. Contact: Congress Secretariat 28th IGC, Faculteit Ruimtelijke Wetenschappen Universiteit Utrecht, Postbus 80.115, 3508 TC Utrecht, The Netherlands. Phone: 31 30 532 044; Fax: 31 30 540 604; e-mail: r.vanderlinden@ frw.ruu.nl.

7 - 9 August 1996. **Coastal Environment '96: Environmental Problems in Coastal Regions**, Rio de Janeiro, Brazil. Contact: Sue Owen, Wessex Institute of Technology, Ashurst Lodge, Ashurst, Southampton SO4 2AA, UK. Fax: 01703 292 853.

22 - 28 September 1996. **Wetlands for the future: INTERCOL's V International Wetlands Conference**, Perth, Australia. Contact: Secretariat, UWA Extension Conference & Seminar Management, The University of Western Australia, Nedlands, Perth 6907, Australia. Phone: 61 9 380 3181/2433; Fax: 61 9 380 1066; e-mail: uwaext@uniwa.uwa.edu.au.

25 - 27 September 1996. **Federal And International Scientific Permits**, San Diego, California, USA. Contact: Sally Shelton, Director, Collections Care and Conservation, San Diego Natural History Museum, P. O. Box 1390, San Diego, California 92112 USA. phone (619) 232-3821 ext 226; FAX (619) 232-0248; email libsdnhm@class.org

29 September - 2 October 1996. **Natural Disaster Reduction Conference 96**, Gold Coast, Australia. Contact: The Conference Organiser NDR 96, P.O. Box 931, Palm Beach, Queensland 4221, Australia. FAX: (07) 5598 3607.

3 - 6 October 1996. **Australasian Quaternary Association (AQUA) General Meeting**, Apollo Bay, Victoria, Australia. Contact: Geoff Hope, Div. of Archaeology and Natural History, Research School Pacific & Asian Studies, Australian National University, Canberra, A.C.T. 0220, phone: (062) 49 3283, FAX: (062) 49 4917, email: geoff.hope@ coombs.anu.edu.au OR Kate Harle, Department of Geography and Environmental Studies, Monash University, email: Kate.Harle@arts. monash.edu.au

1 - 3 November 1996 **IGCP 396 Continental Shelves - Key sites for Science and Mankind**, Sydney, Australia. Contact: Professor Peter J.Davies, Ocean Science Institute, Edgeworth David

Building, University of Sydney, NSW 2001, Australia.

10 - 12 November 1996. **3rd AINSE Radiation Science Conference (Radiation'96)**, Sydney, Australia. Contact: Mrs Margaret Lanigan, Conference Manager, ANSTO, PMB 1, Menai, N.S.W. 2234, Australia. Phone: (020 439 8220; FAX: (020 439 6561; e-mail: ainse@ansto.gov.au

17 - 21 November 1996. **GIS/LIS '96**, Denver, Colorado, USA. Contact: American Society on Surveying and Mapping. Phone: 301-493-0200; FAX: 301-493-8245.

28 - 31 January 1997. **The Second Institute of Australian Geographers and New Zealand Geographical Society Joint Conference,** Tasmania. Contact: Dr L. J. Wood, Department of

Geography and Environmental Studies, University of Tasmania, Box 252C GPO, Hobart, Tasmania, Australia 7001. Phone: (002) 202489; Fax: (002) 202989 Email: L.J.Wood@geog.utas.edu.au

10 - 13 February 1997. **Sixth Australiasian Archaeometry Conference**, Sydney, Australia. Contact: Mrs Margaret Lanigan, Conference Manager, ANSTO, PMB 1, Menai, N.S.W. 2234, Australia. Phone: (020 439 8220; FAX: (020 439 6561; e-mail: ainse@ansto.gov.au

Century, Suva, Fiji Islands. Contact: Secretariat, VIII Pacific Science Inter-July 1997. **VIII Pacific Science Inter-Congress: Islands in the Pacific** Congress, c/- School of Pure and Applied Sciences, The University of the South Pacific, PO Box 1168, Suva, Fiji Islands. Phone: 679 313 900 ext 2691 or 2430; Fax: 679 302 548; e-mail: pas@usp.ac.fj.

28 August - 3 September 1997. **IV International Conference on Geomorphology**, Bologna, Italy. Contact: IV International Conference on Geomorphology, Planning Congressi s.r.l., Via Crociali 2, 1-40138 Bologna (Italia).

June 1999. **19th Pacific Science Congress**, Sydney.

CONFERENCE REPORTS

THE LINNEAN SOCIETY OF NEW SOUTH WALES QUATERNARY SYMPOSIUM, WELLINGTON CAVES, NSW, 4-6 DECEMBER

Geoff Hope

Any doubts that the Quaternary is a disjointed field were dispelled for the author when he made the transition from a climate change meeting in Melbourne in late November to the well-publicised Quaternary Symposium a fortnight later at Wellington, one of the birthplaces of the study of the Australian Quaternary. Roughly similar numbers of people graced both meetings, but only Stuart Pearson and myself attended both. So who were the mystery non- AQUA Quaternarists? Mostly zoologists, that's who, many with a major interest in Tertiary as well as Quaternary time. Well represented was University of NSW Biology (e.g. Terry and Lyn Dawson, Deborah Morris, Mike Archer, Sue Hand, Henk Godthelp, Mike Augee) and Flinders University (e.g. Rod Wells, Steve Salisbury, Gavin Prideaux and Pyramo Marianelli).

The conference had wonderful weather and kicked off with an atmospheric first session in Cathedral Cave where I well remember being informed by a cave guide that the limestone breccia infilling an old pipe was a volcanic neck from the eruption that caused the cave. David Ride and Angela Davis reviewed the faunal history of the eastern highlands and Lyn Dawson and Mike Augee talked about the long history of exploration of fossils from Wellington. This was the place from which the earliest giant marsupials were first described by Richard Owen. We departed the cave for a lush morning tea and occupied a hall for the remaining sessions. The day continued with bone deposits from Jenolan, Bingara, Wellington, Katherine and Venus Bay; as Quaternarists bone people certainly get into their work. The day finished with a tour led by Armstrong Osborne of Phosphate Cave, a cave originally mined for phosphate and now being restored as a tourist attraction. The site of so many palaeontologists drooling over the bones sticking out of the wall emphasised how difficult it is to restrain the treasure hunting impulses; the walls seemed a little barer after the crowd had passed and the Thylacine jaw I had spotted seemed to have disappeared, no doubt to be catalogued.

Palaeontologists follow the theory that to appear young, always be seen in the company of things zillions of years older than oneself. At least they all made a beeline for the oldest shanty in the district and cries of “bullshit it’s a new species”, “Flannery’s wrong” “ziphodont my arse”, and “mine is bigger than yours (an obscure selenodont fragment)” echoed into the night. The next day expanded out to the faunas of Australia and extinction chronologies. The smoking gun was notably absent but Alex Baynes presented a critical analysis of the dating of extinction sites that leaves it available. Then it was time for evolution in crocodilians both terrestrial and lagoonal, carnivorous wallabies and a few remarks about *Megalania* and pythons that made us all feel distinctly unsafe about visiting the Pliocene with 12 tonne dragons hanging about. Right at the end of the day Stuart Pearson talked about the Holocene stick nest rat deposits and brought the time scale back to more familiar territory.

The final day returned to crocodiles and other oddities, such as fossil frogs, pollen and geomorphology. The Tertiary palaeontologists were called away to face TV cameras and hunt bats as Bob Galloway reconstructed the climate at Lake George and the Snowy Mountains as lying precisely at -8°C and *ca* 50% of present precipitation. This condition was met at extreme glacial times only. The conference ended with a tour of Burrendong Arboretum where a very impressive Araucarian rainforest has been established with the help of shading and some watering; a sort of living Hamilton in the dry hills of the western slopes.

The conference will be reported by a special volume of the Linnean Society of New South Wales, edited by Mike Augee, who is to be congratulated on an innovative and well run field meeting. The friendly staff of the Caves house added to the hypothesis that provisioning for conferences is usually better in the country (e.g. Nerriga, Mallacoota). For a palynologist, the meeting had lots of interest and food for thought; I encourage Quaternarists to mix into meetings outside their own strict chronological, palaeontological, geological, palaeoclimatological or archaeological mileux.

THE LATE-GLACIAL PALAEO-OCEANOGRAPHY OF THE NORTH ATLANTIC MARGINS: A MEETING OF IGCP PROJECT 253: TERMINATION OF THE PLEISTOCENE EDINBURGH, SCOTLAND 5-7 JANUARY 1995.

Stephen J. Gale

After an introductory overview of North Atlantic oceanography by Thiede, the first session of the meeting dealt with the palaeo-oceanographic evolution of the region. Robinson *et al*. introduced two themes which were taken up by several subsequent speakers. First was the concept of 'Heinrich events', short-term episodes of ice-rafted debris (IRD) influx to a depositional site (Heinrich, 1988). Secondly was the use of magnetic susceptibility as a rapid means of identifying IRD in marine cores. Amongst other conclusions Robinson *et al*. noted that the IRD records of 17 cores indicated a focusing of icebergs on the cyclonic northeast Atlantic gyre. Spectral analysis of the magnetic susceptibility data revealed not only that the cyclicity of the susceptibility peaks conformed with that of the three primary Milankovitch frequencies, but also that changes in the frequency of susceptibility patterns were identical with shifts in the cyclicity of the orbital cycles over time.

Cronin *et al*. used ostracods to reconstruct Late Quaternary North Atlantic oceanography. A notable finding was the close relationship ($r = 0.75$) obtained between water temperature and the Mg:Ca ratios of shells from the ostracod genus *Kithe*. This is similar to that obtained by Corrège, De Deckker and Chivas (in submission) for the same genus in the Coral Sea.
Duplessy added to the well-established picture of a steep oceanographic temperature gradient at the latitude of northern Spain at the time of the last glacial maximum. This thermal front appears to have coincided with a high salinity gradient. To the south, high rates of evaporation appears to have resulted in high salinities, whilst to the north, cooler conditions gave rise to lower salinity waters.

Spielhagen and Bauch considered Late Weichselian water mass exchanges in Fram Strait, the only gateway between the Arctic Ocean and the Norwegian-Greenland Sea. Like many other speakers, they identified IRD in their cores simply on the basis of grain size (specifically, peaks in the frequency of grains coarser than 63 and 500 µm). Such an approach raises the issue of the adequacy of this definition. Studies of deposition in modern fjords have shown that although large volumes of material may be transported by icebergs, none of this is necessarily coarser than silt size. The existence of coarse material in marine cores may thus be a reflection of glacial dynamics rather than sediment influx.

Bausch presented high resolution palaeoenvironmental data covering the last 27 ka from a core from the eastern Iceland Plateau. Fragments of grey sandstone in the sediments revealed that the maximum extent of the ice sheet occurred at 20-19 ka. by contrast, the $\delta^{18}O$ record showed that the thermal last glacial maximum took place at 16-15 ka. Is this discrepancy a result of the dependence of ice sheet growth on moisture supply? Or is it a consequence of local ice sheet dynamics as opposed to larger-scale climatic controls?

Weinelt *et al*. obtained evidence of surface temperatures of 3-4°C during the last glacial maximum in the Nordic Seas. This contradicts the conventional view as espoused by CLIMAP (1981) of a perennially ice-covered ocean in the region at this time.

The second session of the meeting focused on the high latitude North Atlantic. Andrews and Jennings considered the eastern Canadian Arctic, identifying some of the first evidence for an 11-10 ka ('Younger Dryas') cooling so far found in the Canadian Arctic.

Osterman *et al*. investigated a series of marine cores from the Yermak Plateau in the Arctic ocean. They found evidence of grounded ice in the area prior to oxygen isotope stage 13. This contrasts with the proposal of Vogt *et al*. (1994) that deep iceberg ploughmarks in the area are a product of last glacial maximum ice.

Boulton presented a series of mathematical models of the Scandinavian ice cap. In a typically wide-ranging paper, one issue of particular relevance to the theme of the conference concerned glacial responses to a brief cold event such as that of the Younger Dryas. Debate rages on the global evidence for the existence of this event. Boulton revealed that whether or not an ice sheet responds to such an event (and thus leaves evidence of its response in the sedimentological and geomorphological records) may depend on whether the ice has a frozen or a sliding bed. If the latter, the ice sheet will possess a gentle profile, retreat during deglacial phases, will be rapid, and freezing of the bed during a short episode of climatic deterioration will merely slow the rate of retreat. In other words, only those ice sheets with frozen beds will leave behind evidence of a Younger Dryas- type cooling.

Hald and Dokken considered a series of high resolution cores from the continental margin of western Svalbard. They found no evidence of a Younger Dryas event, but instead recognised an abrupt two-step warming pattern in the very early Holocene.

Stein studied cores from the fjord of Scoresby Sund in east Greenland. Apart from being able to pinpoint changes in the source of IRD on the basis of the lithology of lithic fragments, he attempted to use magnetic susceptibility as a surrogate for IRD. His finding that several of the IRD peaks in his cores do not coincide with increases in susceptibility casts doubt on the attempts of other workers to use magnetic properties as an index of glacial detritus. The assumptions underlying this thesis are clearly simplistic since the occurrence of IRD-susceptibility peaks is largely dependent on the existence of a recognisable distinction between the magnetic properties of the ice-rafted debris and those of the marine sediments.

Despite clear glacial geomorphic evidence of a Younger Dryas event in east Greenland, Stein failed to recognise any evidence of such an episode in the marine record. One explanation for this may be that Scoresby Sund was frozen over during this time and was thus not capable of receiving an IRD input.

The third session of the meeting focused on detailed records of the chronology of the Late-Glacial. Koç showed that the meltwater signal of the Nordic seas occurred at 14.5-14.1 ka (AMS ^{14}C), approximately 1.5 ka prior to the occurrence of the same signal in the North Atlantic. In other words, deglaciation appears to have begun before significant warming was experienced in the North Atlantic. She also showed that, although the cooling of the Younger Dryas can be identified in a transect of North Atlantic cores between 50°N and 63°N, the magnitude of temperature change during this event declines markedly and systematically with distance south.

Kroon *et al*. identified ash from the 10.3 ka Icelandic Vedde eruption in cores from the Hebridean continental margin. This material is too coarse to have been transported by air and must have been carried south and northeast by icebergs as part of the anticlockwise gyre. There is evidence from the cores that the Younger Dryas is actually composed of two cold events, a later one, The Younger Dryas *sensu stricto,* and an earlier one, the possible correlative of the Amphi-Atlantic Oscillation of Levesque *et al*. (1993).

Björck *et al*. investigated the distinct change in lithology recognised at the start of the Holocene in southern Scandinavian lake sediments. The synchronicity of the change suggests that it was the product of region-wide climatic change corresponding to the end of the Younger Dryas. Detailed investigation of the sedimentary records from this period reveals that lacustrine parameters (such as $\delta^{18}O$ in ostracods) respond immediately to climatic change and indicate a rise in mean annual air temperatures of 6-8^{0}C, whilst terrestrial parameters (such as vegetation) have a lagged response.

Gale & Drysdale presented detailed $\delta^{18}O$ results from a speleothem from the mountains of the Picos de Europa in northern Spain. They showed that temperature change, and hence glaciation, in the mountains was closely related to movements of the oceanic polar front. For most of the last cold stage the Picos de Europa lay within the influence of temperate oceanic waters. Only during the last glacial maximum, and possibly the Younger Dryas, did the polar front penetrate sufficiently far south to bring the mountains within the influence of polar waters.

Wohlfarth *et al*. used the Swedish varve scale to calibrate ^{14}C dates during the Late-glacial. They argued that the differences between their results and the U:Th versus ^{14}C calibration curves of Bard *et al.* (1992) and Edwards *et al.* (1993) cast grave doubts on the acceptability of the Uranium-series calibration.

Similar discrepancies between U:Th and calendar ages were revealed by Hajdas, who investigated the relationship between ^{14}C determinations on macrofossils and varve chronologies in Swiss lakes.

Finally, Heier-Nielsen *et al*. undertook very detailed ^{14}C dating of macrofossil shells from the foraminifera from marginal marine cores from the Skagerrak. In no case are the shells older than the corresponding foraminiferal samples, whereas in some situations the foraminifera are up to 5,000 years older than the shells. This appears to be the result of the depositional site. The result has important implications for those studies which have relied upon foraminiferal dating to provide a chronological framework for deposition.

The final session of the meeting considered the shelf seas and the continental margins. Sejrup reviewed the Quaternary environmental history of the northern North Sea. This experienced glaciation as early as 1.1 Ma. During the Late-glacial, the central part of the North sea was deglaciated by 21 ka, whilst between 18 and 15 ka, lobes of debris flows laid down from surrounding ice coalesced to form the 20,000 km^3 North Sea Fan.

Syvitski summarised the seismic procedures being used by the Geological Survey of Canada to investigate the palaeo-oceanography of Canada's continental margins. One noteworthy point concerned the results of repeat surveys of areas subjected to iceberg scour. In some areas it has been found that ploughmarks can be completely obscured by repeated scour in less than three years. This suggests that in these areas the upper sediments may be totally reworked in a few hundred years.

Shennan compared the empirical and mathematical (rebound) models which have been advanced to explain the Late-glacial sea level histories of Scotland. The results of the two approaches diverge dramatically during the Younger Dryas when the empirical models indicate a marked increase in sea level. Although studies of isolation basins in northwest Scotland reveal no evidence of such a sea level blip in the Younger Dryas, neither do the results fit well with the predictions of the theoretical models.

Rose *et al*. studied a single vibrocore sample from the Danish sector of the North sea. This presents some evidence of near constant sea level over 1.7 ka of the Late-glacial at a time when sea levels elsewhere were increasing dramatically. Rose's attempt to explain this in terms of glacio-isostatic forebulge migration as a result of the unloading of the Scandinavian ice sheet met with considerable scepticism on the part of the audience.

The proceedings were brought to a conclusion by Lowe who reviewed our current understanding of the Late-glacial in the marginal North Atlantic. The best estimates of palaeotemperature in each of the marginal North Atlantic regions were recently summarised by Lowe *et al*. (1994). The main conclusion of this work is that there is a great similarity between those climatic records for the last glacial-interglacial transition derived from ice cores and those from oceanic and terrestrial sites. The dominant pattern is of 14-0 ka climatic oscillation in which the Younger Dryas is a major component, but which varies in timing, form and amplitude from place to place. Thus the Bølling-Allerød Complex and the Older Dryas may simply represent fluctuations superimposed on the decline in temperature to its minimum, Younger Dryas, value. Some of these fluctuations may be region-wide, whilst others may be purely local. Nevertheless, in all cases, the warmings are short and sharp, whilst the cooling are gradual and occur over longer periods. It should be noted that although the Younger Dryas Chronozone is tightly defined as lying between 11 and 10 ka bp, the geomorphic and stratigraphic response may be a consequence of the lagged response of proxy indicators to climatic change; the same situation may apply to the amplification or flattening of the amplitude of stratigraphic response.

Acknowledgements

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PUBLICATION NOTICES

TRANSITIONS: PLEISTOCENE TO HOLOCENE IN AUSTRALIA AND PAPUA NEW GUINEA

F.J. ALLEN & J.F. O'CONNELL

The special issue of *Antiquity* covering the Pleistocene - Holocene transition is available from ANH Publications for $26.00 including postage. The volume is Allen, F.J. and O'Connell, J. F. 1995. Transitions. Pleistocene to Holocene in Australia & Papua New Guinea. *Antiquity* Vol 69, Special Number 265. It includes fourteen articles reviewing environmental change and human response together with articles on crops and agriculture.

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Each set of 20 slides includes vivid photographs of field research conducted around the globe, high-quality graphics of important datasets, and descriptive diagrams, making these sets ideal instructional aides. Included is a narrative that is designed to accompany the slides, a bibliography and a vocabulary list.

Coral Paleoclimatology: Natural recorders of interannual climatic variability in the tropical oceans and seas

Low-latitude ice cores: High resolution records of climate change and variability in the tropics and subtropics.

The slides are available for US$30 per set plus $10 p&p. Cheques and money orders to be made out to Commerce/NOAA/ NGDC.

Orders and further information from:

National Geophysical Data Centre
NOAA, E/GC. Dept. 974
325 Broadway
Boulder, CO 80303, U.S.A.
Phone: 303 497 6227
FAX: 303 497 6513
Internet: info@ngdc.noaa.gov

QUATERNARY E-MAIL LISTS, INTERNET PAGES & ELECTRONIC JOURNALS

Continuing last issue's listing of Quaternary e-mail lists, Internet pages and electronic journals, here are some more that have come the way of the editor.

EPSL ONLINE: EARTH AND PLANETARY SCIENCE LETTERS

http://www.elsevier.nl/locate/epsl

EPSL Online is the online version of *Earth and Planetary Science Letters*, and contains everything published in the parent journal since Jan. 1996. It is updated monthly with the publication of each issue of *EPSL*. A free trial of *EPSL Online* is available. Subscription for 1996, with 50% discount, is US$39 (normally US$80). For 1996, *EPSL Online* is only available as a personal subscription for individuals working at institutions which maintain a subscription to the journal *Earth and Planetary Science Letters*. Library licence to *EPSL Online* may become available in the future.

For further information, contact:

Elsevier Science
C.P.M. Pallandt
Sara Burgerhartstraat 25
1005 KV Amsterdam,
The Netherlands
Fax: +31 20 485 2696

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QUATERNARY RESEARCH ASSOCIATION WWW

The June 1996 QRA Circular (minus tables) is now available on the WWW at the QRA home page:

http://www2.tcd.ie/~pcoxon/circ3.html

You can also access the Circular through Pete Coxon at the following address:

Pete Coxon,
Department of Geography
Museum Building
Trinity College
Dublin 2, Ireland.
Phone: (01) 6081213; mobile: 088 574496
FAX: (01) 6713397

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IRISH ASSOCIATION FOR QUATERNARY STUDIES (IQUA) WWW

The Irish Association for Quaternary Studies (IQUA) has established a home page on the world wide web:

http://www2.tcd.ie/~fmitchll/iqua.html

This page can also be accessed via the Quaternary Research Association (QRA) home page. For further details, contact:

Fraser Mitchell
School of Botany
Trinity College
University of Dublin
Dublin 2, Ireland
Phone: +353 1 6081811
FAX: +353 1 6081147

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QUATERNARY ENVIRONMENTAL NETWORK (QEN) WWW

A preliminary version of the Quaternary Environment Network (QEN) atlasof land ecosystem types (*sensu* Olsen *et al.*) Is available on the WWW at:

http://www.soton.ac.uk/~tjms/adams1.html

It consists of an extensive text-based literature review and some roughly-hewn maps of palaeovegetation/ecosystem cover for each region of the world at the last glacial maxium, the early Holocene (8 ka), and the mid-Holocene (5 ka). The QEN database is being produced as part of the work of the new INQUA Commission on Land Carbon, with the aim of quantifying bio-geochemical fluxes involved land ecosystems on the glacial-interglacial timescale.

For further information, contact:

H.Faure,
INQUA Commission on Carbon,
LGQ-CNRS Case 907
Faculte des Sciences de Luminy,
13288 Marseille cedx 09 France
FAX: 33 91 41 3879
email: faure@riou.univ-mrs.fr

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THE 2ND IAG & NZGS JOINT CONFERENCE WWW

Details regarding the 2nd joint conference of the IAG and NZGS can be found on the University of Tasmania WWW page:

http://www.geog.utas.edu.au/iag97

For further information, contact:

Dr L J Wood
Department of Geography and Environmental Studies
University of Tasmania
Box 252C GPO, Hobart
Tasmania, Australia 7001
Phone: (002) 202489
Fax: (002) 202989
Email: L.J.Wood@geog.utas.edu.

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INQUA COMMISSION ON GLACIATION WWW

The INQUA Commission on Glaciation has set up a home page at

http://geology.wisc.edu/cog

with overall description of the commission, its working groups and meetings. The site will be updated to keep you informed about current activities of the commission.

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AUSTRALIAN ARCHAEOLOGISTS WWW PAGE

http://www.arts.su.edu.au/Arts/departs/archaeol/austarch.html

At present this just contains names and email address. For inclusion, send the following information by email to Ian Johnstone on:

johnson@felix.antiquity.arts.su.edu.au

so that Ian can add it to your entry (please don't send it in hardcopy, as Ian doesn't have the time/staff to scan or retype the information): affiliation, addres,s phone and FAX nos., home page address (departmental or personal), brief summary (1 paragraph) of professional interests (can be descriptive or just a series of keywords).

If you are doing anything with GIS, please write an EXTRA paragraph on your GIS work which Ian will forward to the special list of GIS-using archaeologists being developed by Paul Miller and Ian.

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GEOMORPHLIST

GEOMORPHLIST is a moderated electronic mail distribution list for geomorphologists and those working in related fields. It is used for professional communication on topics of interest to geomorphologists. An updated directory of members of the list is distributed occasionally. For further information contact:

Jeff Lee
Dept. of Economics and Geography
Texas Tech University
Lubbock, Texas, USA 79409-1014.
Phone 806-799-4278
Fax 806-742-1137.
E-mail adgjl@ttacs.ttu.edu.]

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ASSOCIATION OF POLISH GEOMORPHOLOGISTS

http://hum.amu.edu.pl/~sgp/welcome.html

The Association of Polish Geomorphologists web site has some good stuff on it including a series of maps of the world during the last part of the Quaternary, and the beginnings of a "virtual textbook". Have a look at it!

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TROPICAL GEOMORPHOLOGY NEWLETTER

Issues 16,17, 18 and 19 are now available at the TGN home page. The URLs of these issues are:

http://zikzak.net/tgn/issues/i16.html
http://zikzak.net/tgn/issues/i17.html
http://zikzak.net/tgn/issues/i118-19.html

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JOURNAL OF PALEOLIMNOLOGY (JOPL) WWW HOME PAGE

The new URL address for the Journal of
Paleolimnology Home Page is:

http://www.umanitoba.ca/faculties/
science/geological_sciences/
PALEOLIM/ jopl.html

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ISOGEOCHEM STABLE ISOTOPE LIST

ISOGEOCHEM is an E-mail Discussion List in Stable Isotope Geochemistry. The Department of Geology, University of Vermont (Burlington, USA), has recently launched this stable isotope geochemistry e-mail discussion list. The objectives of the ISOGEOCHEM list are to promote the exchange of news and information among those with an interest in stable isotope geochemistry, and to provide new contacts and enhance collaboration among researchers from different disciplines (e.g. geology, biology, chemistry). The list is intended not only as a discussion forum for isotope geochemists but also as a source of information and help for researchers from other fields interested in applying stable isotopes as an additional tool in their own studies. Currently, about 450 researchers from all over the world have joined the list.

To subscribe, contact:

Dr. Andrea Lini
Stable Isotope Laboratory
Department of Geology
University of Vermont
Burlington, VT 05405 USA
Phone: (802) 656 02 45
Fax: (802) 656 00 45
E-mail:alini@moose.uvm.edu

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ARCHAEOBOTANY LIST

The aim of this list is to facilitate communication through the exchange of information on meetings, conferences, bibliographies, publications, reference collections and botanical and ethnographic data relevant to the analysis of archaeological plant macro-remains.This group could also exchange ideas about various aspects of archaeobotany such as problems of methodology, identification, presentation and interpretation.

To subscribe send the following command:

subscribe archaeobotany your full email address

to:

listproc@eng-h.gov.uk

For further information, contact:

Sarah Mason
Department of Human Environment
Institute of Archaeology
University College London
31-34 Gordon Square
London, WC1H 0PY, UK
sarah.mason@ucl.ac.uk
Tel: 0171 380 7484
Fax: 0171 383 2572

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PALEOLIMNOLOGY AND DIATOM WWW PAGES

Just a note to invite readers to visit the Paleolimnology WWW page. The URL is:

http://www.indiana.edu/~diatom/
paleo.html

For those interested in diatoms, please visit the diatom home page by substituting diatom.html in the above address, or just branch.html as your bookmark so you can get to both the diatom and paleo Web pages.

For more information for Web and DIATOM-L business, contact:

Roger Sweets
University of Louisville
502-852-8261
sweets@ucs.indiana.edu

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SOCIETY FOR ARCHAEOLOGICAL SCIENCES SASnet MAILING LIST

SASnet, the mailing list for the Society for Archaeological Sciences, is now open to those who are not society members. This list was established to facilitate discussion about the applications of methods from the physical/natural sciences to archaeological problems. It's intended to provide a resource for archaeologists who need access to technical expertise and a forum for physical/natural scientists to discuss the development of archaeological applications of their methods. A significant fraction of our members are geoarchaeologists and others interested in late Quaternary chronology. The list is moderated and, at least at present, a 'quiet' one. If you are interested in subscribing, send the subscribe command:

SUBSCRIBE SASnet <your name>

to:

listserver@relay.doit.wisc.edu

For further information, contact:

J. Burton
Anthropology Dept.
Univ. Wisconsin-Madison
jhburton@facstaff.wisc.edu

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COLBY COLLEGE, MAINE QUATERNARY WEB PAGE

Two WWW pages are devoted to the Quaternary program at Colby College, Maine, with a principle focus on Quaternary paleoecology (using mainly pollen, plant macrofossils, and subfossil insect remains). The address is:

http://www.colby.edu/geology/Quaternary.html

For further information, contact:

Robert E. Nelson, Chair
Department of Geology
Colby College
5804 Mayflower Hill Drive
Waterville, Maine 04901-8858 USA
Phone: [207] 872-3247
FAX: [207] 872-3555
e-mail: renelson@colby.edu

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POLLEN ANALYSIS SOFTWARE ON WWW

There is now a **TILIA** list on the internet:

tilia-l@lists.colorado.edu

Address a message to:

listproc@lists.colorado.edu

with the contents of the message being:

subscribe tilia-l <their-full-name>

The subject line of this message should be blank.

For more details, contact:

Dr. Eric C. Grimm
Illinois State Museum
Research and Collections Center
1011 East Ash Street
Springfield, IL 62703 USA
phone, office: 217-785-4846
phone, database: 217-524-0493
Fax: 217-785-2857
E-mail: grimm@museum.state.il.us

Concerning a guide for Tilia and TilaGraph, note that there is a six-page expansion of the menu structure printed in one of the INQUA Data-Handling Newsletters. You can pick up a self-expanding file called TILMENUZ.EXE from the INQUA File Boutique. When the file is on a DOS computer, typing TILMENUZ (enter) will cause the file to expand into a PostScript file that can be sent directly to a PostScript printer. The Boutique's www address is:

http://geology.wisc.edu/~maher/inqua.html

and by anonymous ftp: geology.wisc.edu

cd to pub/inqua and type bin or binary before getting tilmenuz.exe.

For those interested, the Data-Handling Methods Newsletter will appear again this (nothern) summer. To get on the mailing list or receive more information, contact:

Louis J. Maher
Geology & Geophysics
Univ. Wisconsin, Madison WI 53706
maher@geology.wisc.edu
phone: (608) 262-9595
Fax: (608) 262-0693

There's also **PSIMPOLL** and **PSCOMB** downloadable from the paleoecology WWW page at Cambridge University. PSIMPOLL and PSCOMB can generate nice diagrams and do some useful statistics. They are written by Keith Bennett at Cambridge and he keeps updating them The latest editions of both programs and manuals are available, free of charge, from:

http://www-palecol.plantsci.cam.ac.uk/

There is a program for the Psion organiser pocket computer called **POLLTAX** which is used for pollen tally counts, also freely available from the site above. The three (i.e. PSIMPOLL, PSCOMB AND POLLTAX) programs are designed to work together and with the aid of a 'comms-link' to your desktop computer from the Psion, data entry is rapid and precise. For more information, contact:

Adam Gardner
Dept. of Plant Sciences
University of Cambridge
Downing St.
Cambridge CB2 3EA U.K.
tel:+44 (0)1223 330217
Fax:+44 (0)1223 333953
email: arg24@cus.cam.ac.uk

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OAK RIDGE NATIONAL LABORATORY DISTRIBUTED ACTIVE ARCHIVE CENTER (ORNL DAAC)

Announcing an upgrade to our Information Management System (IMS). With this new version, users now can search for and acquire data held at the ORNL DAAC with improved functionality,
including:

* Geographical querying from a world map
* Chronological querying
* Data browsing capabilities
* View order history and status of orders
* The ability to change user passkey and to leave comments

Through the ORNL IMS, users can access site-specific, ground-based data such as temperature, moisture, carbon dioxide, radiation, soil moisture, and vegetative growth, as well as regional- and global-scale data and information useful for understanding global change. The ORNL IMS can be accessed by issuing a telnet command to the following
address:

ornlims.ornl.gov 6493

The IMS can also be accessed from the ORNL DAAC WWW HomePage available at the following URL:

http://www-eosdis.ornl.gov

The Oak Ridge National Laboratory (ORNL) Distributed Active Archive Center (DAAC) is one of nine DAACs sponsored by NASA as part of the Earth Observing System Data and Information System (EOSDIS). The lab focuses on biogeochemical dynamics and ecological data based on field measurements with world-wide coverage and on providing data to the global change research community, decision makers, educators, and the general public. For further information, contact:

Jerry Curry or Merilyn Gentry
ORNL DAAC User Services Office
Oak Ridge National Laboratory
P.O. Box 2008, MS 6407
Oak Ridge, Tennessee 37831-6407
USA
Telephone: (423) 241-3952 (8am-5pm EST)
FAX: (423) 574-4665
E-mail: ornldaac@ornl.gov

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GEOPHEMERA ON-LINE

A WWW-based version of Geophemera, the non-publication of the British Geomorphological Research Group is now available from:

http://ggg.qub.ac.uk/andy/bgrg/geophem/index.htm

For more information, contact Brian Whalley on email:b.whalley@qub.ac.uk

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LITHICS-L

Hugh Jarvis has started a listserv list called Lithics-l. It will be for the discussion of all matters pertaining to the analysis of archaeological lithics, natural and artificial. It will include the usual space for discussion, queries, and hopefully solutions (!) relating to theory, method and research information. Characterisation andsourcing, dating, structral and technological analysis, nomenclature, and so on will be appropos. Artifact style andform will only apply when they relate to the former. For further information, contact Hugh Jarvis at:

hjavis@acsu.buffalo.edu

AMQUA WWW HOMEPAGE AND EMAIL CONTACT

The American Quaternary Association, (AMQUA) WWW homepage is:

http://cc.usu.edu/~Dkaufman/AMQUA.html

An email contact for AMQUA is Jim Mead:

jim@nauvax.ucc.nau.edu

EQMAL EUROPEAN QUATERNARY MALACOLOGISTS

EQMal (European Quaternary Malacologists) has its own homepage. The URL of this page is:

http://www.inter.nl.net/users/Meijer.T/eqmal.html

QUATERNARY AUSTRALASIA PAPERS

Paper: Quaternary Australasia 14/1 (1996)

A RECONSTRUCTION OF LAST GLACIAL MAXIMUM SEA-SURFACE TEMPERATURES IN THE AUSTRALASIAN REGION

Barrows, T.T.[1*], Ayress, M.A.[1#], and Hunt, G.R.[1]

[1]Australian Quaternary Climates Database, Environmental Geoscience and Groundwater, Australian Geological Survey Organisation, Canberra, ACT 0200, Australia
[*]Research School of Earth Science, Australian National University, Canberra, ACT 0200, Australia
[#]Department of Geology, Australian National University, Canberra, ACT 0200, Australia

Abstract
A large body of data on Australasian Quaternary climates is now held in the Australian Quaternary Climates Database (QUATDB), compiled and administered by the climate change group at the Australian Geological Survey Organisation (AGSO). The database presently contains a variety of information including past sea surface temperatures, vegetation changes, faunal changes, glacial limits and lake levels. From this information, maps have been developed of sea surface temperature during the Last Glacial Maximum (LGM), and compared with present day conditions.

These maps form part of an ongoing project at AGSO to document climate change in the Late Quaternary. Version 4 of the maps is presented here and earlier versions were presented at the CLIMANZ IV conference, the AGC conference and in Barrows (1995). Version 4 supercedes previous versions as it incorporates new data, more accurate coastlines, and a more rigorous control on the quality of estimated palaeotemperatures.

The Australian Quaternary Climates Database (QUATDB)

The aim of the project is to utilise the database to produce palaeoclimatic maps for comparison with palaeoclimatic model outputs. This was to be accomplished by extracting relevant information from the published record including the author's climatic interpretations. More recently, it was decided to enhance the role of the database as a site for data storage and access for researchers. To this end researchers are being encouraged to supply data sets and site information to the database. This is especially important in cases where the published record is incomplete or presented in an unsatisfactory way. Links have been established with the World Data Centre - A (WDC-A) for Palaeoclimatology in Boulder, Colorado. The WDC-A has pioneered free access to large quantities of palaeoclimate-related data on the computer network. QUATDB now has the potential to act as a regional centre for palaeoclimatic data. A link to the database (either a full link or a limited set of queries) will be developed on the World Wide Web. No external access is currently available.

Data sources

This reconstruction of the LGM February and August (Figures 1 and 2) in the Australasian region draws mainly on data published in seven references: Moore *et al.* (1980), Prell *et al.* (1980), CLIMAP (1981), Prell (1985), Anderson *et al.* (1989), Wells *et al.* (1994) and Miao *et al.* (1994). These studies have employed transfer function and modern analogue techniques to derive sea surface temperatures from microfossils (foraminifera, radiolaria and coccolithophora) sampled from deep ocean cores.

The maps presented here consist of the most reliable, regionally consistent data from 100 cores. These cores include

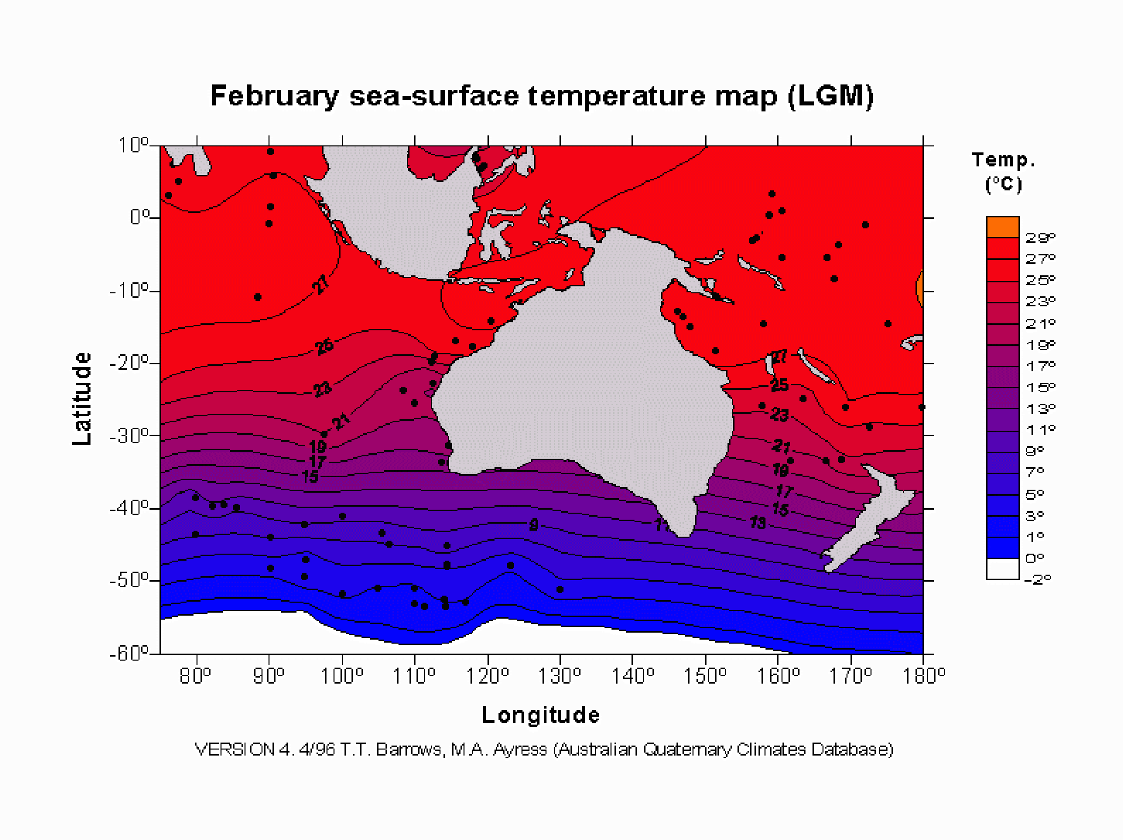

Figure 1

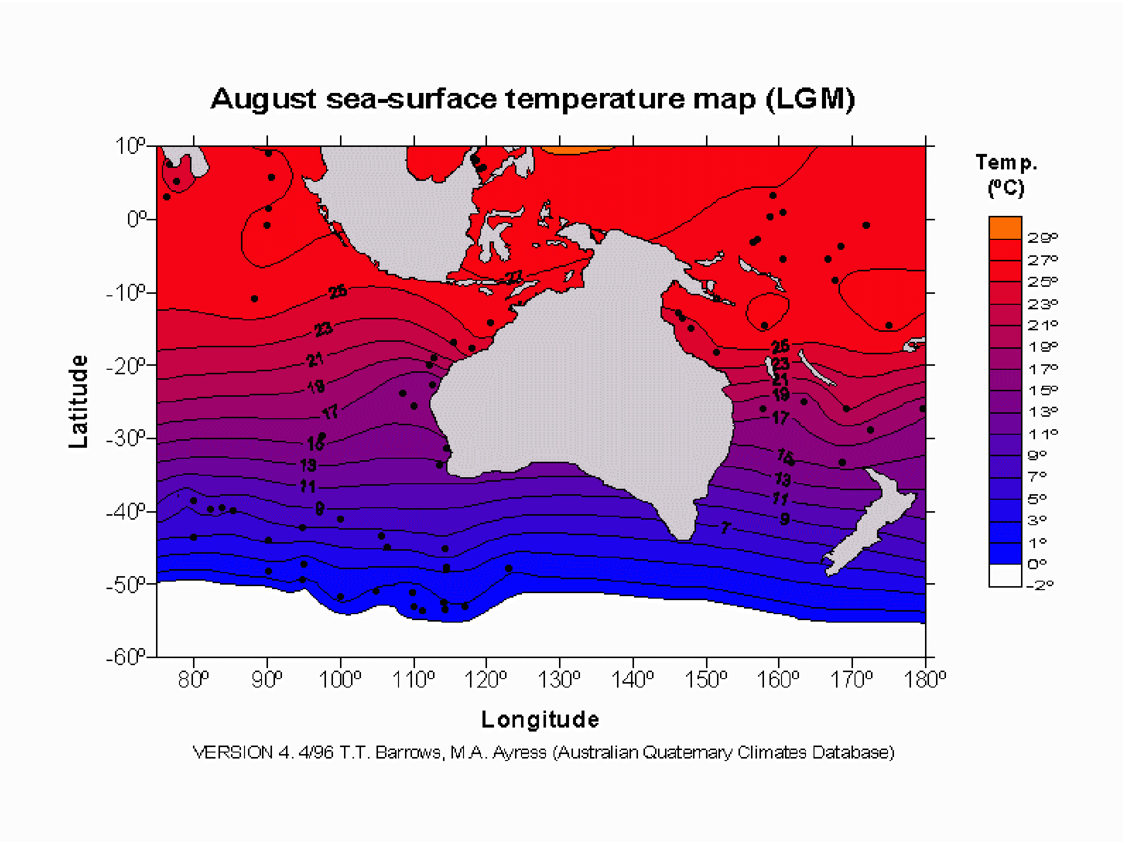

Figure 2

estimates from up to 15° outside the region to constrain the position of isotherms at the edges of the maps. Modern sea-surface temperatures were taken from the World Ocean Atlas (1994), and used to compare with the LGM temperatures in order to determine temperature anomaly maps (Figures 3 and 4). The coastline on the LGM maps represents the modern -200 m bathymetric contour from the GEBCO atlas. This was the closest available digital contour to the -120 m level representing the LGM shoreline. The modern coastline is taken from the Digital Chart of the World.

LGM February and August maps: departure from modern conditions

These maps are the first reconstruction of LGM sea-surface temperature for the Australasian region since CLIMAP (1981). The new maps offer a refined reconstruction as they incorporate new data published during the last 15 years, use a standardised modern sea-surface temperature dataset, and an improved technique of regional surface contouring.

The isotherms on the LGM maps follow a similar pattern to that of the present day with some distinct changes in oceanography. The anomaly maps highlight several regions of interest:

- strong cooling off the western Australian coast
- slight cooling in the eastern Tasman Sea
- slight cooling in the equatorial Western Pacific in winter
- strong cooling in the high latitudes
- slight warming to unchanged temperatures north of New Zealand in summer

The cooling off Western Australia may be due to a strengthening of the Western Australian Current cooling waters further north than it does today (*cf* Prell 1980). The LGM maps indicate a movement of subantarctic waters into the southern Tasman sea. This suggests a weakening of the East Australian Current during the LGM. This result conflicts with the original CLIMAP findings where a 4°C warm anomoly was indicated. The cooling along the equator is similar to that shown by CLIMAP and suggests a contraction of the 'warm pool' north of Australia during August. The cooling of 3-4°C in the west equatorial Pacific during August appears to be the result of an intensified South Equatorial Current supplied with cooler water from the Peru/Chile Current. The cooling in the high latitudes corresponds with a northward extension of sea-ice during both seasons.

The warm anomaly north of New Zealand appears to be robust and is reproduced by the modern analogue technique as well as transfer functions. However, the magnitude of the anomaly lies within the error bars of both methods. This region also registers an increase of 3-5°C in seasonality compared to the present. There is support for a climatic contrast between the east and west sides of the Tasman Sea from the terrestrial records. The temperature depression on the North Island of New Zealand was only of the order of ~4°C (e.g. McGlone *et al.*, 1978) whereas it was 6-9°C in southeastern Australia (Barrows, 1995).

Most of the sea-surface temperatures presented here have been determined from foraminifera and radiolaria. There is a need to compare this data with other methods to determine whether the temperature estimates are realistic (e.g. Thunell *et al.*, 1994) as sea-surface temperatures in the coastal areas do not always correspond with the terrestrial temperature records. For example, coastal New South Wales showed only 3-4°C of cooling whereas temperatures on the Southern Tablelands were colder by 9°C (Barrows, 1995). Similarly off New Guinea, sea-surface temperatures were only 1-2°C colder whereas terrestrial estimates indicate 5-8°C of cooling (e.g. Hope *et al.*, 1976). Increases in lapse rates during glacial periods (corresponding to a drier atmosphere) account for only some of this difference. The difference in sea-level (~120 m) can also only account for up to 1°C of the difference.

The core distribution is still inadequate for reasonable reconstructions of the southern Tasman Sea, central Indian Ocean and

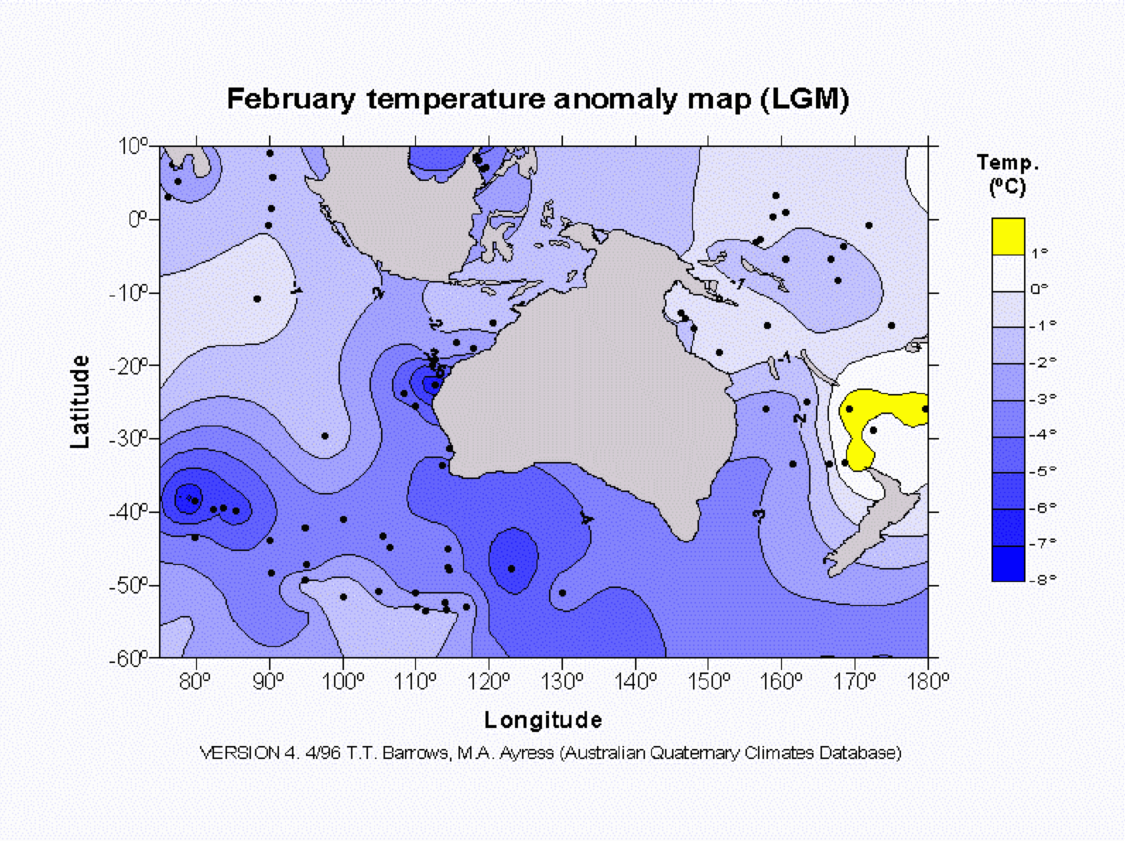

Figure 3

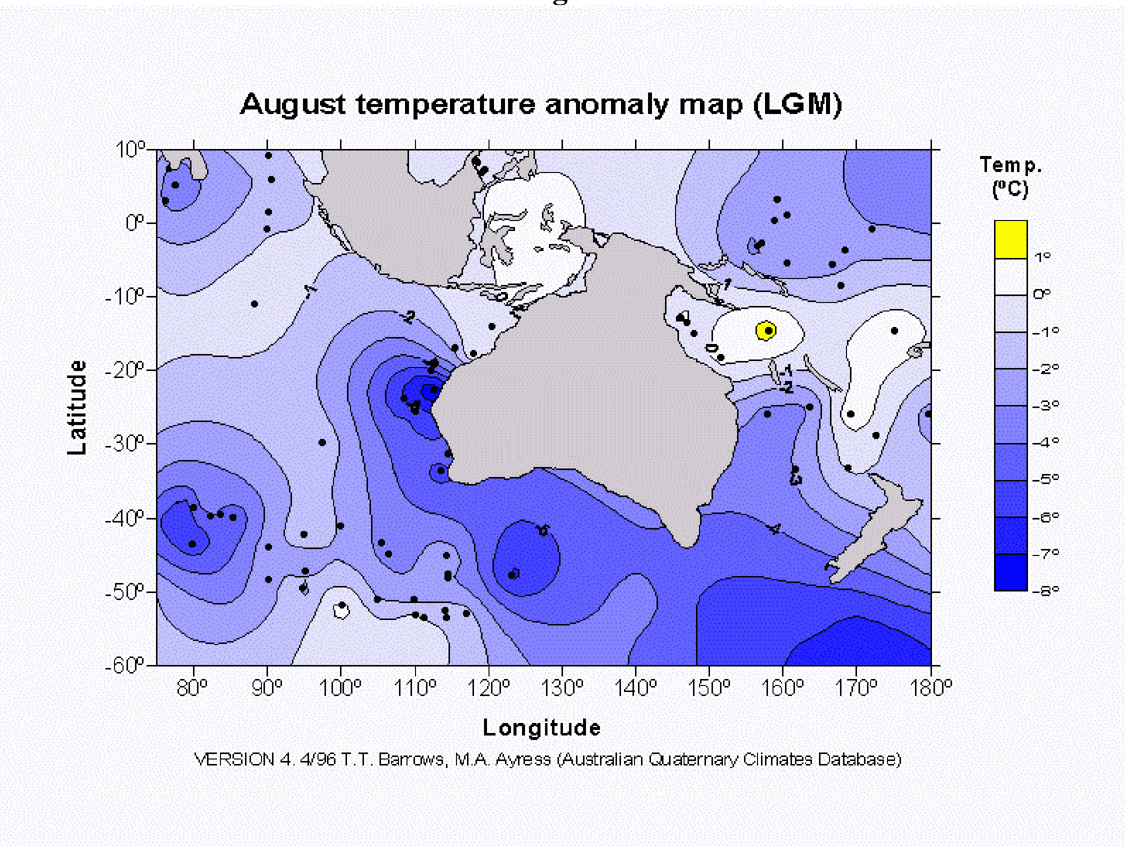

Figure 4

north of Australia. These areas need to be the focus of future research in Australia, using as many techniques to determine sea-surface temperature as possible. In particular the application of the modern analogue technique on coccolithophora and radiolaria would be welcome in these areas and on already existing data. The current development of the modern analogue technique and the transfer function method on diatoms (e.g. Dansie, in preparation) promises to shed light on temperature changes in the high latitudes.

Conclusions

The palaeoclimatic maps presented here represent the first product of the Australian Quaternary Climates Database. Changes in oceanographic circulation and the position of oceanic fronts can be determined through comparing these maps with modern conditions. This reconstruction highlights the need for further study on the unresolved discrepancy between the marine and terrestrial temperature records during the last glaciation. It also shows the advantages of a centralised Quaternary database for storing data concerning past climates. The maps included here can now be used to update older CLIMAP (1981) reconstructions in the area. They will also provide more accurate boundary conditions for models simulating the climate of the Last Glacial Maximum.

References

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Prell, W.H., Hutson, W.H., Williams, D.F., Bè, A.W.H., Geitzenauer, K. & Molifino, B. 1980. Surface circulation of the Indian Ocean during the Last Glacial Maximum, approximately 18,000 yr. B.P. *Quaternary Research*, 14:309-336.

Prell, W.H. 1985. *The stability of low-latitude sea-surface temperatures: an evaluation of the CLIMAP reconstruction with emphasis on the positive SST anomalies*. US Department of Energy, Office of Energy Resources, Carbon Dioxide Division, Washington, D.C., 60 pp.

Thunell, R., Anderson, D., Gellar, D. & Miao, Q. 1994. Sea-surface temperature estimates for the tropical Western Pacific during the Last Glaciation and their implications for the Pacific Warm Pool. *Quaternary Research*, 41: 255-264.

Wells, P. E. & Wells, G. M. 1994. Large-scale reorganization of ocean currents offshore Western Australia during the Late Quaternary. *Marine Micro-paleontology,* 24:157-186.

QUATERNARY AUSTRALASIA PAPERS

Paper: Quaternary Australasia 14/1 (1996)

RESERVOIR MODIFICATION OF RADIOCARBON SIGNATURES IN COASTAL AND NEAR-SHORE WATERS OF EASTERN AUSTRALIA: THE STATE OF PLAY

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[2] Quaternary Dating Research Centre, Division of Archaeology and Natural History, Australian National University, Canberra ACT 0200, Australia.

(Correspondence to Dirk Spennemann: e-mail dspennemann@csu.edu.au)

Abstract

The radiocarbon (^{14}C) activity of an ocean water sample varies at any given point in time and space depending on the concentration of surface air (CO_2) absorbed into the seawater in relation to ^{14}C -depleted deep ocean waters brought to the surface by currents and upwelling. The carbon precipitated by marine organisms (corals/shell) reflects this ^{14}C activity, and returns an apparent older age. Local inshore effects, such as terrestrial run off or input of ^{14}C-depleted ground water, as well as offshore influences such as localised currents, have been shown to influence the determinations. Unless sub-regional correction factors are developed as based on a series of systematic studies, the present practice of age determinations may result in misleading interpretation of data.

Introduction

The world's oceans are a reservoir of water that slowly exchanges CO_2 with the atmosphere. Since shells and corals precipitate calcium in the form of calcium carbonates in equilibrium with the surrounding seawater, they are indicators of changes of CO_2 in the seawater at the depth of their growth and thus have been used successfully to document changes in the ocean water regimes (Rafter & O'Brien 1972; Kroopnick *et al.* 1977; Broecker *et al.* 1980; Linick 1980). At any given point in time and space, the ^{14}C concentration of ocean surface and near-surface water depends on the ^{14}C concentration of surface air (CO_2) mixed into the seawater by wave action and precipitation, and the concentration of ^{14}C-depleted deep ocean waters, carried to the sampling location by deep water upwelling and ocean currents (cf. Brown *et al.* 1993). In coastal areas non-marine carbonate from terrestrial run-off or ground water discharge has to be taken into consideration as well (*cf.* Willkomm 1986). Because of the presence of ^{14}C-depleted waters, ocean waters exhibit an apparent age greater than that of the time of collection. Changes to any of the above contributors will result in changes of the apparent age of the ocean water, and by implication to the apparent age of the marine organisms (shell or coral) thus dated (Keith & Anderson 1963; Mook & Vogel 1963; Druffel & Suess 1983; Gupta & Polach 1985; Druffel & Williams 1991).

Marine organisms, especially shell and shell grit, but also coral, have been used extensively in geomorphological and archaeological studies assessing the formation of storm-beaches, cheniers, and shell middens. These studies have contributed greatly to our understanding of past climatic and environmental regimes, such as cyclone frequencies (*cf.* Hayne 1995), storm surges (*cf.* Hopley & Harvey 1978), beachridge formations (eg. Thom *et al.* 1981; Roy 1990), sea-level fluctuations (eg. Woodroffe *et al.* 1986; Bird 1988; Chappell *et al.* 1983), changes in estuarine conditions (eg.Woodroffe *et al.* 1986), environmental change (eg. Spennemann *et al.* 1989), as well as beach formation processes in general (eg. Shulmeister &

Head 1993). On the archaeological side these studies have provided dates for past patterns of human habitation in Australia (eg. Bowdler 1977; Beaton 1985), the time depth of Aboriginal utilisation of coastal resources (eg. Bird & Frankel 1991; O'Connor & Sullivan 1994), as well as the interaction between coastal resource use and sea-level changes (eg. Godfrey 1989; Barker 1991). Beyond their immediate research aims, these studies in themselves are crucial to understanding implications of past environmental processes for the present and future consideration of greenhouse-gas induced climatic change.

Ocean reservoir factors

Any regional or subregional comparison of individual sites relies on the dating of these sites in absolute terms. To securely anchor these observations within the absolute time scale, however, there is a need to account for the apparent age difference between terrestrial/atmospheric and marine ^{14}C ages. There are four ways in which ocean reservoir factors can be determined:

- by dating sections of cores of live corals with well developed growth bands;
- by dating long-lived live shells with well developed growth bands;
- by dating preferably short-lived shells which have been collected to the nuclear testing-induced rise in global ^{14}C ('pre-bomb shells'); and
- by establishing 'pairs' of shell and charcoal dates from archaeological features.

The last approach has potential methodological problems inasmuch as an absolute contemporaneity of archaeological samples has to be established, *ie.* the shells and the charcoal *must* date exactly the same event.

Correction factors were calculated using pre-bomb shells for Australia as a whole (Gillespie 1990; Gillespie & Polach 1979); South Australia (Bowman & Harvey 1983); North-Western Australia (Bowman 1985); New Zealand (McFadgen 1978) as well as the tropical Pacific (Tonga; Spennemann 1989). Occasionally shell/charcoal pairs were also used (Gillespie & Temple 1977; Bowman & Harvey 1983; Head *et al.* 1983; Ambrose 1988).

Often, however, ocean reservoir factors are used as pooled means to correct ^{14}C-dates. Stuiver *et al.* (1986) recommend a pooled mean derived from actual determinations made for Enewetak (Marshall Islands), Hawaii and the Society Islands, and used a ΔR value of 100 ± 24 for the Stuiver & Reimer (1986) computer program. While initially seen by many archaeologists as a 'first approximation' (Kirch & Hunt 1988, p. 162) this pooled value ΔR value has now become widely accepted without any critical evaluation (Kirch *et al.* 1989).

For many Australian, and in fact Western Pacific geological and geomorphological studies, the 450 ± 35 year factor put forward by Gillespie & Polach (1979) has been widely used (eg. Chappell *et al.* 1983; Polach 1987). Yet, when looking at the study of Gillespie & Temple (1977), we note the absence of uniformity and the presence of a regional variation.

Limitations of universal correction factors

The use of such universal reservoir correction factors, or the use of universal global box models of ocean to surface air interactions (*cf.* Oeschger *et al.* 1975; Broecker *et al.* 1980), as used in current ^{14}C calibration programmes (Stuiver *et al.* 1986; Stuiver and Brazunias 1993), is very coarse grained and is fraught with problems. Large localised variations in ^{14}C signatures in shells have been recorded (Dye 1994).

In an archaeological example on Tonga it could be shown that ^{14}C dates on shell provided partially inverted sequences compared to a pottery sequence derived from pottery-form changes through relative (stratigraphic) time. It could be documented that water balance conditions (and hence mixing of ^{14}C depleted ocean waters) and non-marine carbon input via ground water discharge were not universal. Therefore a differential reservoir effect needed to be taken into account, one for the open coast and one for the partially enclosed lagoon, the latter being in fact the greater (Spennemann 1989, Spennemann & Head in prep. a). Had a methodologically independent assessment of the sequence not been conducted, the initial interpretation based on universal reservoir effect corrected dates would have provided an erroneous sequence of the settlement history (Spennemann & Head in prep. a). In geomorphological assessments, such independent verification has often been impossible for want of methodologically independent sources. Shulmeister & Head (1993) could show in a case study on Groote Eylandt that the phenomenon of the hardwater effect needs to be taken into account in geomorphological studies and that, with careful sample selection, analysis and interpretation, it can be recognised as an influential factor.

Further work on Tongatapu has shown that the ground water influx in fact varies over time, adding other levels of uncertainty, in part caused by the gradual change of the shape and hydrology of the lagoon (Spennemann & Head in prep. b).

Based on the previous discussion, it can be suggested that each locality appears to have its own individual signature, and that, therefore, the application of a universal correction factor is inappropriate.

Sea-surface water studies and coral cores

This is borne out by sea surface water studies (GEOSECS; eg. Oestlund and Stuiver 1980) and coral core studies which are suitable tools to add spatial and/or chronological dimensions to the analysis. In 1980 Linick showed latitudinal variation of ^{14}C activity ($\Delta^{14}C$) of inorganic carbon dissolved in surface waters of the Pacific (Linick 1980). The 1957-59 data showed limited variation, with lower ^{14}C activity in the equatorial regions and at latitudes ≥50°N and ≥50°S. The effect of nuclear testing is significantly visible in subsequent years, with increases in ^{14}C activity in both hemispheres, peaking at ~30°S and ~30°N. The equatorial region again showed comparatively low ^{14}C activity, which can be explained in terms of oceanography, as the equatorial current brings ^{14}C depleted deep waters to the surfaces.

Brown *et al.* (1993) could show that changes in the ocean current regime brought about by the El Niño/Southern Oscillation phenomenon brought different water masses close to the Galapagos Islands, and that due to differential mixing of deep ocean waters the $\delta^{14}C$ values varied. The analysis of coral core data for the period of 1970 to 1973 showed $\delta^{14}C$ variations ranging from -1 ± 4 ‰ to +54 ± 5 ‰. These data have implications on the interpretation of shell data as the apparent ages will vary depending on the age at death of the organism and the shell region dated.

The Australian situation

Cores of live corals reaching back to the 1850s or earlier should show evidence of both the fossil fuel dilution of atmospheric CO_2 and (later) the nuclear bomb-induced ^{14}C spike, both of which are well documented phenomena in the terrestrial carbon environment and thus form suitable indicators. Corals analysed at the Great Barrier Reef (Abraham Reef) have shown no evidence of the fossil fuel effect caused by the industrial age (Druffel & Griffin 1993). This effect, however, is visible in the dendrochronologically derived atmospheric data (Stuiver & Becker 1993; Stuiver & Pearson 1993). On the other hand, a coral core off the Florida keys showed both the fossil fuel effect and the subsequent bomb spike (Druffel & Linick 1978), as did corals in Belize (Druffel 1980) and Galapagos (Druffel 1981). It is possible, as Druffel and Griffin (1993) point out, that medium- to long-term ocean current variations may well mask the fossil fuel effect in the Abraham Reef core. Whilst several central Pacific cores are too short to show the fossil fuel effect, they document great variability as far as the bomb-spike is concerned (Druffel 1987). Druffel's work has clearly documented the regional and subregional nature of the ^{14}C variations in the Pacific Ocean and its correlation with oceanographical phenomena.

Duffel's work has also shown the capacity of coral core profiles to aid the understanding of short- and medium-term variability of ocean currents and exchanges of water masses. These data are eminently useful for the reconstruction of past oceanic conditions and the ocean's responses to CO_2 variation in the atmosphere, such as generated by the fossil fuel effect in the past, or global warming at present.

The estuarine areas of Australia, ranging from open estuaries such as the Burdekin River or the Alligator Rivers (Woodroffe *et al.* 1986), to partially or fully enclosed lagoons (Bird 1984), show a range of freshwater to seawater relationships, necessitating the development of a localised, estuary-specific ocean reservoir correction factor. In addition, the lagoons change physical shape over time (Thom *et al.* 1981; Bird 1984), with a concurrent change in the lagoon versus. terrestrial water relationship. This suggests that the carbon ratios are likely to fluctuate similar to the Tongan example mentioned earlier.

Thus any ocean-based ocean reservoir study needs to be complemented by coastal and estuarine data sets. Indeed, archaeological and geomorphological samples are only very rarely derived from open ocean sample locations and samples drawn from coastal and estuarine locales form the overwhelming majority. Yet, the coastal situation cannot be understood without a comprehension of the wider implications of the oceanic ocean reservoir effect.

Implications of current practice

At present the use of universal ocean reservoir factors not only potentially masks chronological variations, but potentially invalidates some observations *in toto*. The development of localised and subregional ocean reservoir correction factors has allowed the resolution of chronological sequences in the fields of archaeology (see above), coastal storm ridge formations (eg. Shulmeister & Head 1993), and should be able to do the same for coast and beach formation and past sea-level changes.

Some other concerns

As already noted, the stability of an ocean reservoir factor over time is another concern. While there are studies which attempt to derive a fossil ocean reservoir correction factor and compare this with a recent sample (*cf.* Southon *et al.* 1992), such studies are at present lacking for the Australian environment.

Of related concern is that an atmospheric correction ('calibration') of marine samples has been advocated by Stuiver and Brazunias (1993) and many 'date end-users' calibrate their dates accordingly. However, if the fossil fuel effect can be masked on oceanic coral cores as shown by Druffel for the Abraham Reef core (Druffel & Griffin 1993), or if large-scale current variations can occur on a short term basis as shown by Brown *et al.* (1993) for the Galapagos, is it not reasonable to expect that the lesser variations posed by the atmospheric ^{14}C variations, while reflected in the tree rings, will also be masked in ocean water, and that, therefore, any correction thus applied may turn out to be spurious? There is an obvious and urgent need to empirically assess the correlation of the carbon isotope signatures in tree rings with those in coral and long-lived shell such as *Tridacna*.

The way ahead

There is an urgent need to solve this issue by a systematic study. Unless the localised effects modifying ocean reservoir correction factors are determined for the entire eastern seaboard of Australia at least on a subregional scale, present and future ^{14}C based age determinations are likely to be less useful than otherwise possible. This has severe implications on the suitability of such data especially for interregional comparisons in fields of study as far apart as the assessment of insurance risk in relation to environmental responses to changed conditions of the ocean regime on the one hand, and investigations of human habitation and coastal land use through time on the other.

A systematic study of ^{14}C variations in space and time in eastern Australia and islands of the southwest Pacific would ideally be based on coral cores and *Tridacna* slices used in tandem to account for possible differences in the precipitation of carbonate by shells and corals, which should be recognisable as ^{14}C variations. As many of the geomorphological and most of the archaeological ^{14}C determinations in coastal midden sites are made on short-lived shell species, there is a further need to correlate the long-term sequences with short lived shell specimens. This approach also allows us to assess to what extent short-lived species with known collection dates can used as proxies for coral cores or *Tridacna* cross-sections.

In order to achieve a subregional resolution, the sample locations can be selected according to the following three criteria: (i) latitudinal spread of sample sites; (ii) position in relation to freshwater discharge sources (such as rivers); (iii) coastal versus near shore locations.

The results of such work would be directly applicable to a variety of lines of inquiry in a variety of disciplines, as they are set to provide:

- baseline data on ocean water composition through time at various points of the Australian east coast at a sub-regional resolution;
- improved understanding of influences of oceanic currents on coastal waters

and their variability through time at a sub-regional resolution;

- improved understanding of the signature of environmental change (eg. fossil fuel dilution of atmospheric CO_2 due to increased CO_2 emissions in the industrial age);
- baseline data to use that signature in assessing global climate change;
- localised and subregional ocean reservoir correction factors to improve accuracy of ^{14}C dates;
- improved site-specific resolution of the reconstruction of climatic and environmental change;
- improved reliability of inter-regional observations of reconstructions of climatic and environmental change; and
- an improved reliability of inter-regional observations of human habitation and coastal land use patterns through time.

Beyond this, on a more fundamental level, the underlying parameters of carbon incorporation in shell (Broecker 1963; Mook & Vogel 1968; Emrich *et al.* 1970; Erlenkeuser *et al.* 1975) and coral (Druffel & Suess 1983) may need to be reassessed using laboratory-growth conditions as provided by controlled tank environments. As the need for ever finer archaeological and geomorphological chronologies increases we need to revisit some of this ground: Are the shells in equilibrium with the surrounding seawater or are there systemic/systematic effects, such as temperature and light that need to be considered? Is it possible to relate the coral-derived values directly to shell-derived samples, or need a correction occur? And if so, what is the magnitude of these influences?

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QUATERNARY AUSTRALASIA PAPERS

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LATEX PEELS: OVERCOMING THE PROBLEM OF BLOCKED SPRAY NOZZLES

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The paper by Colley (1995) prompted me to write up the solution to a problem that I first encountered in 1976 while collecting soil profile peel, using latex, for our teaching set. I used the method explained to me by Peter Mitchell (Mitchell, pers. comm. 1976; see also Mitchell & Paton, 1988, who, in turn refer to Riley & Riley, 1974 and to Cappel, 1973).

One of the greatest difficulties encountered during that work was posed by the drying out of latex in the nozzle of the hand pump when a fine spray was required on a hot dry day. Perhaps this was because the latex product available to me was not ideal for the method that uses the "modified garden sprayer" (see Mitchell & Paton, 1988, p. 440). The device represented in the figure (next page) is designed to allow flushing of the spray hoses and nozzle. It also allows latex to be sprayed at a constant rate, thus reducing the scope for latex to dry in the spray nozzle during operation. The latex is poured into the cylinder from the outlet end, with the piston hard up against the inlet end. Upon pumping of water into this end, the piston is driven along the cylinder, thus forcing the latex along the hose and through the nozzle. When all the latex has been expelled, the piston pin valve is activated by contact with the outlet end of the cylinder, thus allowing the hose and nozzle to be flushed with the water that hitherto has provided the pressure for driving the latex through the nozzle. Thus pressure on the spray nozzle is maintained and flushing is immediate upon delivery of all the latex in the cylinder.

The device depicted in the figure was made in the workshop of the Monash University Department of Physics from stainless steel type of OD 90 mm and ID 80 mm. The length of the cylinder is 300 mm. The sealing rings were easily obtained from *Bearings Services*, and water pressure pumps of the kind needed and depicted in the figure are available from any agricultural or engineering supliers (e.g. *Blackwoods*). The hose and its fittings are standard plumbing pressure fittings.

In addition to solving any nozzle drying problems, the device offers an additional advantage: it is virtually clean and ready for wiping down and storage immediately upon finishing the final spraying. This is in contrast to the garden sprayer which, as often as not, I found had to be discarded after only a few uses with the latex product that was available to me at the time.

Happy peel collecting! The ones I collected in 1977 are still being used in soil practical classes. This durability may be explained not only by the care with which they are or are not handled, but also by the amount of soaking with latex (which in the first soaking should be dilluted, but in later ones be more concentrated) I was able to give them on a hot day (the best time to collect peels is when the soils are not waterlogged!) in preparation for the painting on of the cheesecloth. I did not use Cappel's method of hastening the setting of the latex between coats (by spraying with a 9%

solution of acetic acid) and so cannot comment on the amount of corrosion that would result if the pressure water was used for this, but that perhaps the acetic acid solution would be best applied with an ordinary hand-pumped atomiser.

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PALYNOLOGICAL INVESTIGATIONS IN SOUTH AFRICA

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Abstract

South Africa, in contrast to the northern Hemisphere, has few detailed palynological studies of environmental fluctuations through time. Due to the paucity of the available data and the large expanse of land that this data represents, it is not possible to accurately undertake a comparative study, and the patterns of environmental change are still relatively unclear. However, there has been a steady increase in the use of pollen analysis in recent palaeoenvironmental studies. The data generally conforms with palaeoclimatic reconstructions based on other such techniques, and what is required is both a broader data base and replication of this data for this climatically and floristically diverse region. This review places all the available palynological data together and interprets the South African palaeoclimate according to the evidence provided.

Introduction

Pollen analysis in South Africa was pioneered during the 1950's by van Zinderen Bakker (1951, 1955, 1957, 1962) and Coetzee (1967). In comparison with the temperate regions of the northern hemisphere where numerous pollen profiles have been produced, only a few have been studied in South Africa and, in general, this is also the case for the rest of Africa. The only exception is perhaps East Africa, where a number of long pollen profiles have been studied (Coetzee, 1967; Hamilton, 1982; Bonnefille & Riollet, 1988) and more recently the Congo (Elenga *et al*., 1994). Palynological research in South Africa is hampered by the lack of polliniferous deposits due to the acidity of the area and generally the mineral rich deposits of Quaternary age in this region do not preserve useful pollen assemblages (Scott, 1984a). All palynological sites described in the article are represented in Figure 1.

Pre-Holocene

The longest pollen sequence for South Africa is published by Scott (1982a, b) from an organic thermal spring deposit cored at Wonderkrater, west-central Transvaal. The sequence has twelve radiocarbon dates, covering approximately the last 35,000 years, which has been subdivided into ten pollen zones. Furthermore twenty-five modern surface pollen spectra, twenty-one from the Transvaal and four other sites were examined to help evaluate the fossil pollen assemblage. Deacon & Lancaster (1988) point out that some of the radiocarbon samples from the Scott (1982a, b) study appear to have been contaminated and have given dates that are out of chronological order in the stratigraphic succession, thus estimates have been calculated and used to describe the sequence.

Another, potentially, long or old pollen sequence is from the Pretoria Soutpan on the Zoutpan farm approximately 40 km north of Pretoria (Scott, 1988a). A 3.1 metre core from the site provides an age of 5,590 ± 80 years BP (Pta-4271). On the basis of this data it has been estimated that the bottom sediment, in excess of 170 metres, is approximately a quarter of a million years old. This age will have to be verified by K/Ar dating of magma below the sediments. The most recent date is that of 200 000 years reported in Partridge *et al*. (1993).

A sequence which may yet prove to be as old as the previous two, and older than initially proposed, comes from Florisbad, 48 km north-west of Bloemfontein in the Orange Free State (van Zinderen Bakker,

Figure 1: Map of South African palynological sites. The region is divided into ecozone regions described by Klein (1984) and Deacon & Lancaster (1988).

Locality codes: 1 - Theuniskloof/Tugela (Scott, 1984a); 2 - Scott (Scott, 1982b); 3 - Tate Vondo (Scott, 1987a); 4 - Wonderkrater (Scott, 1982a; Scott and Thackeray, 1987); 5 - Soutpan, Pretoria (Scott, 1988a, Partridge *et al*., 1993); 6 - Moreletta River (Scott, 1984a, b); 7 - Rietvlei (Scott & Vogel, 1983); 8 - Elim (Scott, 1986a; 1989a, b); 9 - Cornelia (Scott, 1986a; 1989a, b); 10 - Craigrossie (Scott, 1986a; 1989a, b); 11 - Florisbad deposits (van Zinderen Bakker, 1957); 12 - Deelpan (Scott, 1988b); 13 - Maluti Mountains (van Zinderen Bakker, 1955); 14 - Equus cave (Beaumont *et al*., 1984; Scott, 1987b); 15 - Wonderwerk cave (van Zinderen Bakker, 1982); 16 - Kathu Pan (Beaumont *et al*.,1984); 17 - Aliwal North (Coetzee, 1967); 18 - Winterberg (Meadows *et al*., 1987; Meadows & Meadows, 1988); 19 - Blydefontein Basin, Noupoort (Scott & Bousman, 1990); 20 - Compassberg (Meadows & Sugden, 1988); 21 - Nuweveldberg (Sugden & Meadows, 1989); 22 - Badsfontein, Venterstad (Scott & Cooremans, 1990); 23 - Boomplaas (Deacon *et al*, 1984); 24 - Norga and Gwayang (Scholtz, 1986); 25 - Groenvlei (Martin, 1968); 26 - Cape Hangklip (Schalke, 1973; Scott, 1984b); 27 - Noordehoek (Coetzee, 1986); 28 - Cederberg (Meadows & Sugden, 1990, 1991a,b).

1957). This thermal spring has a 7 m high mound of spring deposited sand with interbedded organic horizons, some of which contain pollen. When initially described by van Zinderen Bakker (1957), the radiocarbon dates indicated a Holocene aged assemblage. Since then a second set of dates has suggested that, at least, the upper part of the sequence dates to between 29,000 and 19,000 BP (van Zinderen Bakker, 1967, 1976). More recently it has been established that most of the pollen bearing sequence is beyond the range of radiocarbon dating and is of a minimum age of 35,000 years (Kuman & Clarke, 1986).

A pollen sequence from Noordhoek, on the Cape Peninsula, has an undated Quaternary spectrum that overlies a much longer sequence recording vegetation changes from Late Oligocene through Miocene and Pliocene times. The pollen evidence shows that marked changes in the vegetation of the Cape occurred several times during the Miocene. Fossil pollen points to a subtropical nature of the riparian forest and that some grassland and fynbos was already present in the vicinity. These interpretations relating to the Late Miocene are confirmed by the occurrence of a fossil fauna including grazers and browsers in the early Pliocene (Coetzee, 1976, 1978, 1986).

From the available data it is evident that considerable environmental changes occurred in the Late Quaternary before 25,000 BP (Scott, 1983, 1990). The Wonderkrater and Pretoria Soutpan sequences show evidence of a cool, moist forest with more *Podocarpus* pollen which was replaced by drier, slightly warmer savanna (Scott & Thackeray, 1987) before the onset of the Last Glacial Maximum.

For the time period 24,000 to 16,000 BP biological data consistently indicates a cold and generally dry glacial climate with unusually low species diversity, which is a regular feature of harsh Glacial Maximum environments (Deacon & Lancaster, 1988). From the Boomplaas Cave in the foothills of the Swartberg, southern Cape interior a distinct contrast is observed between pollen counts of the Last Glacial Maximum, dated to *ca*. 20,000 BP, and those dated to within the last 10,000 years. The Last Glacial Maximum samples have a low species diversity of nine pollen types of which five are Asteraceae with a single type *Elytropappus* accounting for 78% of the Asteraceae. The Holocene samples have between 30 and 40 pollen types that are still dominated by Asteraceae but with high percentages of types such as Poaceae, Restionaceae and *Euclea*. In addition an older pollen sample dated *ca*. 32,000 BP with a spectrum similar to that of the Last Glacial Maximum samples is present, but *Elytropappus* accounts for only 58% of the Asteraceae. The obvious difference exhibited by glacial and interglacial vegetation surrounding the cave was the substantial increase in species diversity occurring after *ca*. 14,000 BP. Also whereas the glacial vegetation was dominated by Asteraceae, the Holocene spectra included more arboreal elements (Deacon *et al*., 1984a,b; Deacon & Lancaster, 1988).

The Boomplaas Last Glacial Maximum zone has been used as evidence of a 5-6°C drop in temperature from present day conditions. Combined with a reduced effective precipitation this envisaged environment would be so impoverished, with regards to species, that no modern analogue exists. Similar impoverishment in vegetation at this time has been noted in the Transvaal at Wonderkrater (Scott, 1982a) and from Craigrossie which is situated in the Clarens area of the foothills of the Lesotho Highlands (Scott, 1986a). Scott tentatively recognizes seven distinct pollen zones spanning the last 20,000 years. It appears that conditions prior to 12,600 BP, possibly back to 20,000 BP, were relatively cool and dry. However, there is insufficient data from other regions to determine or indicate whether this phenomenon was widespread in South Africa.

Towards the end of the Pleistocene relatively moist conditions are evident from the Wonderkrater sequence (Scott, 1982a) and the Clarens area sequences (Scott, 1986a) which exhibit warmer and relatively moist conditions. Further evidence for a moister environment is obtained from Tate Vondo in Venda (Scott, 1987a) and Aliwal North (Coetzee, 1967).

A markedly wetter phase immediately following the Last Glacial Maximum has been postulated. At Boomplaas the pollen spectra showed that between 14,200 and 12,000 BP *Olea* woodland replaced the previously open vegetation, indicating more rainfall and higher temperatures. Similar evidence has been collected from Craigrossie (Scott, 1986a) and Aliwal North (Coetzee, 1967). At Craigrossie slightly more consistent *Podocarpus* pollen in zone CR 1 (<12,500 BP) indicated that forest expansion occurred in mountain ravines, and Scott (1986a) makes the point that temperatures are similar to present levels at some stage between 12,600 and 10,700 BP The Aliwal North site situated at the ecotone between the dry semi-desert Karoo in the south and the subhumid grassland in the north yielded some "interesting climatic variations" (van Zinderen Bakker & Coetzee, 1988, p. 166). At 12,600 BP pure grassveld, indicative of colder and more humid conditions prevailed. This vegetation was replaced twice by warm dry karroid vegetation and after 10,000 BP the climate again warmed and dried so that karroid vegetation became established at *ca*. 9,600 BP (Coetzee, 1967). The wide spread Pleistocene wetter phase is further recognized in organic sediments from Cape Hangklip (Schalke, 1973), Dunedin and Salisbury in the Winterberg (Meadows *et al*., 1987), Kathu Pan (Beaumont *et al*., 1984) and Rietvlei in the Transvaal (Scott & Vogel, 1983).

An undated series of pollen samples from an alluvial terrace and a spring on the farms Theuniskloof and Tugela along the Limpopo River in the northern Transvaal indicates cooler conditions with more open bushveld than at present which could date either to the end of the Pleistocene or to the early Holocene (Scott, 1984b). This sequence is repeated from the Inyanga Highlands in Zimbabwe that dates from *ca.* 12 000 BP to modern times (Tomlinson, 1973, 1974).

A palynological investigation from the Cederberg range in the south-western Cape undertook the coring of two vlei sites: Driehoek and Sneeuberg vleis. Results from the Driehoek core with basal sediments dating to 14,500 BP have been published (Meadows & Sugden, 1990, 1991a, b). The general characteristics of the pollen sequence are: very little marked changes throughout the period of deposition and mesic mountain fynbos has maintained on the Cederberg throughout the late Pleistocene and Holocene. No obvious indication of a marked environmental change at the Pleistocene/Holocene boundary as has been recorded elsewhere (Deacon & Lancaster, 1988).

Holcene

The Holocene, despite the recent accumulation of evidence of Quaternary environments, is still not clearly understood. Van Zinderen Bakker & Coetzee (1988) state that the palynological evidence is not compatible due to the lack of absolute dating and by unclear definitions of the inferred palaeoclimates. During the Holocene time period some sites, with long and detailed sequences such as Wonderkrater, Aliwal North and Boomplaas, show variability with evidence for slightly cooler and warmer intervals, although the overall picture is one of increasing warm temperatures. Fluctuations in both temperature and humidity occurred during the Holocene, but the scale of change was considerably lower than that observed between the glacial and interglacial modes of the Late Pleistocene and Holocene. Therefore Deacon & Lancaster (1988) suggest that terms such as "wetter", "drier", "warmer" and "cooler" should be regarded only as relative estimates in the context of the Holocene.

Gradual warming occurred from *ca*. 11,000 BP until 6,500 BP in the Transvaal bushveld (Scott, 1982a, b; Scott & Thackeray, 1987). Scott (Scott & Vogel, 1983; Scott, 1984a, b, 1987a, b, 1989a, b) has discovered associated patterns of vegetation change. Wet conditions in the Kalahari at *ca*. 7,400 BP have been determined (Beaumont *et al*., 1984), which compare favourably with the coprolite analysis from Equus Cave (Scott, 1987b), and van Zinderen Bakker (1982) infers wetter and warmer conditions from a slightly earlier date of 9,000 BP, continuing until *ca*. 5,000 BP from Wonderwerk Cave. The warmer conditions are observed near Clarens (includes Elim, Cornelia and Craigrossie sites) at *ca*. 10,700 BP (Scott, 1986a, b 1989b), while Coetzee (1967) provides evidence for warming and six stages of alternating wet and dry climates between *ca.* 13,200 BP and *ca*. 9,650 BP from Aliwal North (Scott and Cooremans, 1990).

A different climatic regime comprising either drier conditions, or more even seasonal rainfall distribution, cooler conditions, or a combination of all three probabilities are indicated for late Pleistocene and Holocene valley fill in the Karoo mountains at Blydefontein, Noupoort, Cape Province (Bousman *et al*., 1988), before 7,790 BP.

In the summer rainfall region, the pollen spectra of Wonderkrater, Scot, Moreletta and Rietvlei indicate dry and cool conditions between 10,000 and 8,500 years BP and slightly warmer conditions between 8,500 and 7,500 BP. At Wonderkrater open savanna in the earliest Holocene indicates a slightly warmer but still dry climate. Thereafter the temperature rises gradually up to an estimated age of *ca.* 8,000 BP and remained warmer until *ca*. 4,000 BP after which a cooler episode prevails. During the warmer phase conditions, from changes observed in the arboreal pollen, become slightly more humid. The arboreal pollen increases again during the last 2,000 years as the climate becomes subhumid and warmer (Scott, 1982a).

From the Rietvlei dam in the Transvaal Highveld Scott and Vogel (1983) have identified five pollen zones dating from *ca*. 10,300 to 1,300 BP. At the base of the sequence more open grassland vegetation indicates cooler conditions than those of the present and were replaced by more arid elements up to *ca*. 7,500 BP. Thereafter bushveld expanded with warmer and moister conditions with a climate and vegetation similar to that of the present after *ca*. 3,000 BP. A spring deposit at Scot in the northern Transvaal lowveld has bushveld pollen spectra throughout the last 5,000 years, with lower percentages of arboreal pollen between *ca*. 3,000 and 2,000 BP, suggesting somewhat cooler temperatures at that time (Scott, 1982a). Another Transvaal pollen spectra is the Moreletta River spectra (Scott, 1984a) near Pretoria. The assemblage confirms more open vegetation and cooler conditions prior to 7,500 BP, a wetter and warmer climate *ca*. 5,200 BP, and slightly drier and cooler conditions than the present *ca*. 440 BP. This profile does not, however, provide clear evidence for optimum temperatures during the Holocene although this may be a result of a break in sedimentation within the sequence (Deacon & Lancaster, 1988).

The generalised reconstruction of the Karoo as described from Aliwal North and Blydefontein are strengthened by the pollen data from near the Pleistocene-Holocene boundary from the eastern Cape Winterberg mountains (Meadows & Meadows, 1988). Results indicate possible drier conditions in the early Holocene and moister conditions during the later Holocene after *ca.* 8,000 BP. Early Holocene records from the Cape coastal area is scarce, although at Groenvlei, a coastal site near Knysna, the forests of the regions were reduced between *ca*. 7,000 and 8,000 B.P. (Martin, 1968), while pollen from a peat site at Hangklip in the southern Cape attests to vegetation similar to the contemporary fynbos at *ca*. 7,500 to 6,000 BP (Schalke, 1973).

Groenvlei in the southern Cape is an area that was surrounded by Afromontane forest in historical times and five pollen zones have been recognized in a 7 m lake profile (Martin, 1962, 1968) dated for the last 8,000 years or more. The basal zone indicates a restricted forest with fynbos vegetation reflecting relatively dry conditions with the lowest arboreal count in the sequence. This is below a date of *ca*. 7,000 BP (Martin, 1968) and may in fact be considerably older - possibly as much as 12,000 to 15,000 BP (Deacon & Lancaster, 1988). Zone B2 shows a slight increase in arboreal pollen, suggesting wetter conditions and a spread of forest around 6,870 BP. Zone B3 represents a marine incursion of the lake probably coincident with the mid-Holocene rise in sea level to + 1.5 metres with slightly lower percentages of arboreal pollen and more Restionaceae and Chenopodiaceae which Martin (1968) suggests were the result of either hotter, drier conditions or conditions similar to those of B2. Warmer conditions are confirmed by the range of marine diatoms deposited at this time (Martin, 1968). Although *Podocarpus* pollen is at its lowest level in the next zone, C1, *Euclea* and *Sideroxylon* are prominent indicating a reduction of forest in favour of scrub elements *ca*. 2,000 BP. The return of forest indicated in Zone C2 where *Podocarpus* counts are relatively high are indicative of increased moisture.

Scholtz (1986) has sampled two organic peat deposits in the George district on the Norga and Gwayang rivers. The Norga sequence has a basal date of *ca*. 3,000 BP in one core, but a second undated core is assumed to date from *ca*. 4,000 BP. A cycle of forest advance and retreat is recorded in the sequence, beginning with expansion of forest *ca*. 4,000 and 2,600 BP and a wet local environment. Between *ca*. 2,600 and 1,400 BP, there is a marked forest retreat with a decline in all forest taxa and the disappearance of *Myriophyllum*, a true aquatic. The forest and aquatic taxa are replaced by high percentages of Poaceae pollen suggesting that grassland was prominent on these coastal forelands prior to the advent of European farmers. After *ca*. 1,400 BP *Myriophyllum* and *Podocarpus* reappear and the forest expanded again.

Recent ecological studies in the southern Cape by van Daalen (1980, in Deacon & Lancaster, 1988) have concluded that the forests in this region must be seen as a relict of a much wetter climatic period and therefore suggests that the times of forest advance documented in the pollen record at both Groenvlei and Norga indicate periods of higher effective precipitation in the mid- and later Holocene. As the Afromontane forest is susceptible to summer drought, it may be that these periods of forest advance were triggered by an increase in summer rainfall rather than (or in addition to) an overall annual increase (Deacon and Lancaster, 1988).

A peat deposit where extensive forest was not known in historic times, in the south-western Cape comes from Cape Hangklip, with a basal date of 11,140 ± 65 BP. Fynbos vegetation is represented throughout the time period from *ca.* 6,000 to 2,000 BP with no changes of any significance. However, pollen is not preserved throughout the time represented by the core and changes may have occurred without being recorded (Schalke, 1973; Scott, 1984a).

Palynological work in the Austro-afroalpine belt of the Maluti mountains, Lesotho at an altitude of *ca*. 3,000 metres have not shown significant climatic changes. The oldest radiocarbon data obtained is 8,020 ± 80 years BP, which may indicate that by this date the temperature was favourable enough for pioneer vegetation to become established at that high altitude (van Zinderen Bakker, 1955; van Zinderen Bakker & Werger, 1974).

There is generally progressive warming between 11,000 and 6,000 BP, according to the existing pollen data. For the interior there is distinct evidence for a dry spell in the early Holocene *ca*. 8,000 BP (Deacon & Lancaster, 1988; Scott, 1990). By 6,500 BP relatively warmer conditions had been established at Tate Vondo (Venda), Wonderkrater (central Transvaal), Rietvlei (southern Transvaal), Equus cave and Kathu Pan (southern Kalahari), while cooler conditions developed at *ca*. 4 000 to 2,000 BP (Scott, 1979, 1982a, b, 1984a, b, 1987a, b; Scott & Vogel, 1983; Scott & Thackeray, 1987; Beaumont *et al*., 1984). Scott (1984a) also records a more recent period of unfavourable conditions in the southern Transvaal, from Moreletta river *ca*. 400-500 BP.

At Wonderwerk Cave deposits dates later than 13,500 BP have been recorded in this 140 m deep dolomite cave in the Kuruman Hills (van Zinderen Bakker, 1982). Van Zinderen Bakker identifies three pollen zones: I (9,200 - 5,000 BP) with a spectrum characterizing a climate wetter and warmer than today and open savanna vegetation of tropical affinities; Zone II dates from 5,000 to 3 - 2,000 BP, with the pollen indicating an almost treeless grassland and dry climate; Zone III dates between 2,000 and 1,000 BP, and the inferred vegetation suggests a climate wetter than Zone II and similar to today.

At Kathu Pan (Beaumont *et al*., 1984) the time period 7,400 to 4,500 BP had an open grassland with locally wet habitats. There is evidence of a more varied tree cover, suggesting that the climate was both warmer and wetter than the present, with a high water table permitting peat accumulation on the pan surface. From 4,500 to 2,700 BP, the climate was drier than present and there is a virtual absence of arboreal pollen and species indicating wet habitats. A grassland with locally wet conditions has existed in the region throughout the last 2,700 years.

From 7,000 to 4,000 BP, there is a lack of continuous sequences from the first half of the Holocene from which to derive scale and timing of temperature changes, what is available indicates this was the warmest time at Wonderkrater, Kathu Pan, Equus Cave and Wonderwerk in the summer rainfall region, and Groenvlei (Martin, 1968) and Boomplaas (Deacon *et al.,* 1984) in the all-year rainfall region. From the Transvaalian, Basutolian and Kalaharian ecozones (Klein, 1984; Deacon & Lancaster, 1988) (Wonderkrater, Wonderwerk, Kathu Pan and Equus Cave) there is some indication of increased moisture between approximately 7,500 and 5,000 BP. In the southern Cape moister conditions evident from pollen analysis post-date 7,000 BP (Martin, 1968). While the warm and moist environments of the mid-to-late Holocene in the southern Cape is marked by an increase in forest taxa in pollen sequence from Groenvlei and Norga. Drier conditions are reported from the Basutolian ecozone at Craigrossie (Scott, 1986a).

The last 4 000 years have seen a low level temperature fluctuation around the present-day mean at most sites after 2,000 BP (Deacon & Lancaster, 1988). Between 4,000 and 3,000 BP wetter intervals were recorded at Craigrossie (Scott, 1986a). At Wonderkrater (Scott, 1982a) and Moreletta (Scott, 1984a, b) it appears to have been somewhat drier. Boomplaas suggests warm and mesic conditions with a lower incidence of drought than occurred in early to mid- Holocene times. In the Cape ecozone conditions cooler than the mid-Holocene are suggested in pollen spectra in the last 2,000 years (Martin, 1968; Scholtz, 1986). Optimum conditions for forest expansion in the southern Cape occurred between approximately 6,000 and 2,000 BP when it was relatively warm and moist, because thereafter forest taxa are never as common again.

A moist phase, during which temperatures were slightly warmer than the present, is recorded for *ca*. 5,000 to 3,500 BP, and is indicated by peat initiation or organic deposition (Coetzee, 1967; Butzer & Helgren, 1972; Butzer, 1984; Deacon *et. al*., 1984; Bousman *et al*., 1988; Scott, 1988b). From spring deposits at Badsfontein, central Orange Free State, Scott & Cooremans (1990) suggest "... relatively dry local conditions..." (p. 154) at 4,450 years BP. The work at Wonderkrater (Scott, 1982a), Dunedin (Meadows *et al*., 1987) and Rietvlei (Scott & Vogel, 1983) show earlier peat accumulation, and at Cape Hangklip (Schalke, 1973) and the Little Caledon Valley, Clarens region (Scott, 1986a, 1989b) there are much later phases of organic sedimentation, suggesting a more complex environmental picture.

Good vegetation cover is recorded from Deelpan in the central Orange Free State after 4,000 BP (Scott, 1988b), thereafter drier conditions developed progressively and become well established by *ca*. 820 BP. After 820 BP conditions become slightly warmer, but a relatively poor vegetation cover persisted.

At Blydefontein in the Karoo, the pollen sequence shows a relatively wet grassy karroid vegetation during the last 5,000 years, although Bousman *et al*. (1988) does indicate some moisture fluctuations. Scott & Bousman (1990) also observe moist grassy conditions between 1,200 and 300 BP, but an interval of slightly more shrubby karroid vegetation occurred at *ca*. 1,000 BP from two hyrax middens from Blydefontein. There has been a decrease in grass since 300 BP, apparently caused by relatively dry conditions and later, during the last 150 years, by overgrazing by modern stock farming. Further evidence of disturbance during this period has been observed from the Nuweveldberg and the Compassberg in the Karoo, although it has not coincided with a decline in Poaceae pollen but rather a shift in species composition (Meadows & Sugden, 1988).

A pollen analysis of sediments from the Nuweveldberg mountains in the central Karoo yielded a vegetation history spanning the last 760 years. Multiple discriminant analysis was performed to derive palaeovegetation categories from the fossil pollen data which corresponds broadly with the three contemporary vegetation assemblages in the region. Using statistical analysis the pollen diagram was divided into five zones, representing small, but significant changes in vegetation patterns and hence fluctuations in environmental conditions (Sugden, 1990).

The overall implication is that small fluctuations in climate have occurred over the past 760 years, causing associated shifts in vegetation assemblages. The onset of sedimentation at 760 years is associated with a wetter phase than present, followed by a drier period and possible increases in environmental disturbances due to presence of domestic life-stock. Despite the possibility of overgrazing there is an unexpected increase in Poaceae in the top 20 cm of the spectrum. This increase is associated with *Merxmuellera* grass which is an unpalatable and more hardy grass than *Themeda triandra* which is more sensitive to harsh climates and disturbance (Sugden & Meadows, 1989).

In general the pollen evidence for the last 6,500 years indicates that this phase started with relatively dense vegetation under warmer, moist conditions in most parts of South Africa. During the Holocene there are indications of more open vegetation, related to slight cooling and good availability of moisture, but possibly also related to minor spells of dryness (Scott, 1990).

From the Cederberg range in the south-western Cape, Meadows & Sugden (1990, 1991a, b) discovered a slight increase in families with a weedy habitat or which perform well after fires in the top 100 cm of the sequence. Implications are of increased disturbance towards the present day by European settlers and Khoi herders. There is a decline in Cupressaceae pollen at or near the surface which accords well with the decline in numbers of *Widdringtonia cedarbergensis* due to over-exploitation and an increase in Proteaceae and a decrease in Poaceae. Meadows & Sugden (1990) speculate the increase in Proteaceae as due to the increased intensity of summer droughts.

Conclusion

From the available evidence it seems that the Holocene environmental fluctuations indicate frequent changes which have no definite pattern. However, to date, there are a limited number of palynological studies and dated sites in South Africa and, as Meadows (1988a, b) points out, and as is echoed by Scott (1993), clearly the most obvious problem is that of scarcity of data. With regard to general Holocene vegetation reconstruction, undue weight is given to those few better studied localities that are widely separated in time and space. Truswell & Harris (1982), in an Australian study, point out that the generalisations from such varied and isolated data must be made with caution. What is needed is a broader contemporary pollen-vegetation data base. Meadows (1985) notes the difficulty of assessing the representivity of South African pollen on the basis of such few studies as are presently available. Replication of this data is necessary to eliminate variation over time and so that reliable contemporary palynological data, which can be used as modern analogues in statistical manipulations, is available.

From the palynological data alone a vegetation history of South Africa is slowly emerging, but at present it is greatly under-represented. The results generally conform with reconstructions based on various other methods (Deacon & Lancaster, 1988). More palynological data is required to refine the available picture and future research needs to use modern pollen spectra so as to establish objective transfer functions between fossil pollen spectra and palaeoclimatic conditions. However, evidence for such a relationship is sadly lacking for a greater proportion of the floristically diverse South Africa and thereby hampering palynological research into Quaternary environments.

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QUATERNARY AUSTRALASIA PAPERS

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ENVIRONMENTAL RECONSTRUCTION AT BUNDJALUNG NATIONAL PARK AND BUNGAWALBIN CREEK ON THE NEW SOUTH WALES NORTH COAST

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Abstract of B.App.Sci. Third Year Project Thesis, Southern Cross University, Lismore, Australia.

The north coast region of New South Wales is an area of environmental significance and sensitivity. However few studies have been conducted into the region's environmental history. This study investigates the environmental history of two large peat-bearing deposits located in the environmentally sensitive Bundjalung National Park and nearby Bungawalbin Creek. Both palynological and geochemical analyses were used on core samples to establish the history of the sites. There is doubt about the credibility of the basal radiocarbon date of 8,700 ± 60 years BP obtained for the Bundjalung National Park core, while an age of 6,600 ± 60 years BP for the Bungawalbin Creek site is credible. Fossil pollen evidence from the sites indicates a dynamic past environment, with an overall tendency towards drier conditions. This evidence is supported by charcoal analyses indicating an increase in the occurrence of fire over time. Chemical analyses of the sediments indicate that the Bungawalbin site was strongly influenced by estuarine conditions, whereas the Bundjalung National Park site was only influenced indirectly by estuarine conditions. The information gained from the study has both environmental management and educational values.

COVER ILLUSTRATION

The cover photograph is of the East and West Basin Lakes, near Colac, where a recent application for quarrying in the crater rim between the lakes has recently been rejected by the Victorian Administrative Appeals Tribunal. Peter Gell's comment on this case are included in this issue of *Quaternary Australasia*, in which he commends those Quaternarists whose arguments contributed to this Appeals Tribunal decision. (Photograph courtesy of Peter Gell)