



# Australian Quaternary Newsletter

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# NATIONAL COMMITTEE FOR QUATERNARY RESEARCH

The Academy of Science's Committee has now received the vast total of 21 replies to its questionnaire on the state of Quaternary research in Australia. Undaunted by this overwhelming lack of response, the Committee is going ahead with a review of Quaternary studies in Australia. The purpose is to identify those areas which may be subject to special needs either now or in the foreseeable future. The following people will be providing brief surveys of the state of the art in their fields.

Prehistory: Dr R. Jones, Department of Prehistory, Research School of Pacific Studies, Australian National University, PO Box 4, Canberra, ACT 2600

Soils: Dr G. Beckmann, CSIRO Division of Soils, Cunningham Laboratory, Mill Road, St Lucia, QLD 4067

Palynology: Dr P. Kershaw, Department of Geography, Monash University, Clayton, Victoria 3168

Meteorology and Climatology: Dr P. Webster

Geomorphology: Dr J.M. Bowler, Department of Biogeography and Geomorphology, Australian National University, PO Box 4, Canberra, ACT 2600, and Professor C.D. Ollier, Department of Geography, University of New England, Armidale, NSW 2351

Chronologic Methods: Dr M. Barbetti, Department of Chemistry, University of Sydney, Sydney, NSW 2006

Verbebrate Palaeontology: Dr J. Hope, Department of Prehistory, Research School of Pacific Studies, Australian National University, PO Box 4, Canberra, ACT 2600

If you have any ideas or suggestions regarding the future development of Quaternary aspects of your field, please pass them on to the relevant reviewer.

## RADIOCARBON DATING AT SYDNEY UNIVERSITY

Mike Barbetti and Richard Temple

### INTRODUCTION

Radiocarbon is almost certainly the most widely used dating method for the last 40,000 years. The demand for radiocarbon dates from research workers all over Australia seems to be increasing steadily, to the point at which existing dating facilities are stretched. Kershaw and Peterson wrote briefly on the subject in the last issue of this newsletter. We disagree with some of their statements, but the details are unimportant and we can understand their point of view. Here we outline our current policies for the benefit of users. Elsewhere in this issue you will find a letter from R.B. Temple. We are also planning to send out a questionnaire later this year, and we will write about new research projects in future issues of this newsletter.

The basic principles of radiocarbon dating are described in many books (e.g. Aitken 1974 or Fleming 1976 and we assume that readers are familiar with them.

### SAMPLE REQUIREMENTS

Wood, charcoal, peat, humus, sediments containing organic matter, bones, hair, skin, dried flesh, cloth, paper, most types of shell and inorganic carbonates are all potentially suitable for dating. For the highest precision we require enough sample to yield about 5 grams of pure carbon; samples containing less than this can be dated with a lower precision. Samples with less than 5% carbon attract a surcharge; those with less than 1% will not be processed unless special arrangements are made with us.

Table 1 gives the optimum and minimum dry weights for different kinds of samples. For more detailed information on sample collection we refer readers to the manual by Polach and Golson (1966).



Table 1

Material	Optimum dry weight (grams)	Minimum weight* (grams)
Wood	30-100	3
Hard, lustrous charcoal	10-20	1
Soft or dirty charcoal	20-100	2
Peat	100-200	10
Organic sediments	200-500	20
Bone**	500-2000	300
Clean cloth	30-100	3
Shells	50-100	5
Calcrete	50-300	5

\* quantities as small as this have an adverse effect on the precision of the date, and they attract a surcharge.

\*\* bones readily undergo changes while buried, and special care has to be taken to assess whether or not a C14 date is likely to be reliable. It is our policy to isolate two chemical fractions ('apatite' and 'collagen') from each sample, and date them separately. Bone samples therefore cost twice as much as ordinary samples.

#### SAMPLE SUBMISSION

In principle we accept samples from anyone - universities, CSIRO, museums, research institutes, government departments, commercial interests and the public. We will agree to date the sample if in our opinion it is suitable for dating, if the reasons for doing so are sensible and if the result can be published. These are not trivial matters: sometimes potential submitters have samples which are too small (i.e. they contain less than 1 gram of carbon) or are too dilute or are too old (i.e. older than about 40,000 years) for us to handle. Sometimes radiocarbon dating is not the most appropriate dating method for the problem at hand.

If you have had no experience of having materials dated or if you are not sure how to proceed, call us or write to us and discuss the matter. You should also ask how long we will take to process the sample and give you a result on it. If you decide to use our services you should also ensure that you have or will have funds available to meet our charges, which will vary to meet costs.

#### PACKAGING OF SAMPLES

Samples should be enclosed in polythene bags, glass jars or metal containers labelled EXTERNALLY. Do not put paper tags inside the container; they may contaminate the sample. You should remove extraneous material such as rootlets.

There is a special Sample Record Sheet, available on request, which must be returned (completed) with the sample. NO SAMPLE WILL BE PROCESSED UNLESS SUCH A RECORD SHEET IS PROVIDED. The information you provide is vital in deciding how best to clean and process the material.

If you are planning to submit a series of similar samples you should discuss cleaning procedures with us before we process the first sample. It may even be to your advantage to contemplate the possibility of a joint project with our laboratory.

Confidentiality will be preserved at the time but we will reserve the right ultimately to publish a brief description of the sample, its provenance and age, in our datelists in RADIOCARBON, usually 2 or 3 years after you have received the result.

#### PROCESSING TIME

We normally process samples on a first come, first served basis. There is a backlog of samples and a delay (about 12 months in mid-1980) between submission and dating. If there are no major breakdowns here, and no dramatic increases in demand, we expect the delay to be shorter in future. In the meantime, we are willing to entertain arguments for faster processing on three grounds:

1. The submitter is a postgraduate student and the samples are central to his or her project.
2. The submitter is anyone who needs ONE date quickly in order to decide on a future plan of action. In most cases a new site will be involved and its importance needs to be assessed quickly. Decision-making is a key element in this category.
3. The submitter belongs to a teaching department and a date is required for a class project.

Requests for priority dating on any of these grounds should be made by letter or telephone to Mike Barbetti (address and number at the end of this note). You should explain the nature of the problem, the type of sample and the reasons why you think the sample should be given priority. Samples accepted on this basis take about 8 weeks to process in the most urgent cases. In many cases, however, the submitter has in mind a deadline some months away, and it is easier to accommodate requests for, say, a 6-month turnaround. In order to keep the number of priority samples at a manageable level (about one-tenth of our total output), there is a limit of one sample per submitter per year, and two samples per teaching department per year for category 3.

In other cases where our processing time is unacceptably long, we suggest that you contact Beta Analytic Inc., PO Box 248113, Coral Gables, Florida 33124, USA. If you wish, we can make the arrangements for you and ship the samples to them; results are usually available in about 8 weeks. A small charge is made for our services in this case.



## CHARGES

Ours is a diversified operation, funded partly by Sydney University and partly by income from processing samples. Some special projects are supported by ARGC grants. However, the salaries of the laboratory staff who process customer samples, and the costs of chemicals, computing time, phone calls and stationery, come directly from the money you pay us.

Prices per sample are as follows:

Samples submitted between now and 30 Nov. 1980	\$140
Samples submitted between 1 Dec. 1980 and 30 Nov. 1981	\$160
(note that bone samples will be charged at double rates)	

Surcharge for small samples	up to \$100
Surcharge for bulky samples with 1-5% carbon	up to \$100

Priority service (on merit, in our laboratory)	as above
Priority service (through Beta Analytic, basic price in mid-1980 for normal samples)	\$200

Radiocarbon Laboratory  
Dept of Physical Chemistry  
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Sydney NSW 2006

Phone: 02-6923751  
(direct line to lab.)

## BIBLIOGRAPHY

- Aitken, M.J. 1974 PHYSICS AND ARCHAEOLOGY (2nd ed.). Clarendon Press: Oxford
- Fleming, S.J. 1976 DATING IN ARCHAEOLOGY - A GUIDE TO THE SCIENTIFIC TECHNIQUES. J.M. Dent and Sons Ltd: London
- Polach, H.A. and J. Golson 1966 COLLECTION OF SPECIMENS FOR RADIOCARBON DATING, AND INTERPRETATION OF RESULTS. Australian Institute of Aboriginal Studies, Manual No.2

## DELAYS IN C14 MEASUREMENTS: THE OTHER SIDE OF THE COIN

R.B. Temple

Having just seen 'The Requirements of C14 Dating Users in Australia' by Kershaw and Peterson in the February 1980 Newsletter I feel I must comment from the point of view of someone who has struggled for years to establish one of the 'only two radiocarbon laboratories in Australia' (whatever happened to the others?).

No one who is associated with a C14 laboratory is happy about the delay in reporting ages, but statistical considerations require 5cc benzene samples to be counted at least 16 hours in order to obtain a reasonable precision. With the need to count vial-backgrounds, modern standards and check samples, the throughput of a counter is therefore reduced to between three and four unknowns a week, so that even if it performs faultlessly for 52 weeks in a year, no more than 200 samples can be dated per annum, and this number can be greatly reduced by equipment faults, unfortunately becoming too frequent as the complexity of modern counters increases. Any major breakdown, such as we experienced in 1979, may take several weeks to repair, and has to be followed by laborious resetting of the instrument parameters and redetermination of the vial backgrounds, which also takes weeks. Although we have two counters, one was bought with ARGC funds and is naturally reserved for work on the laboratory's own ARGC projects.

The output from the S.U. Laboratory has always been precarious because this laboratory has had to rely heavily on money obtained from outside the university for its support, particularly to pay an assistant's wages and to purchase some necessary chemicals and small items of equipment. The constant rise in wages has made it impossible to place the laboratory on a sound financial footing, and this is especially felt at present when a greater output of results could be obtained if it were possible to hire an extra pair of hands. This is impossible for lack of money. It is even less possible to contemplate putting money aside for the eventual replacement of our first counter, now 10 years old and nearing the end of its useful life.

The long-term position of the laboratory has been improved by a verbal promise from the university administration that the laboratory will be kept in being after I retire, although not necessarily in the School of Chemistry. However if the university assumes a greater financial responsibility, it will almost certainly insist that Sydney University researchers be 'served first', and this may make the situation worse for Australian Quaternary workers elsewhere. The brutal fact is that it is extremely expensive to set up and operate a C14 laboratory and Australian researchers are not willing or able to pay enough for their dates to support an independent Australian dating



laboratory. An unsubsidised price would most probably be nearer \$500 per sample and we are only able to charge an unrealistic \$140 at present because the university pays a good many of the overheads. How long it will feel justified or able to do so remains doubtful, now money is becoming so scarce.

C14 dating with a dedicated mass-spectrometer cum accelerator is likely to prove even more expensive. Besides the huge cost (\$500,000 for a 'less expensive' system, according to Kershaw and Peterson) for the instrument and its upkeep, the highly professional staff needed to service it and keep it in top running order will, in my opinion, make analyses so expensive that they will have to be limited to very important samples where very little material is available. Nor can I see that the dating limit can easily be pushed back beyond the present practical 40,000 year limit, which arises from the possibility of sample contamination as much as from difficulties of detecting low levels of C14. The accelerator method will be just as much at the mercy of sample contamination as the counting procedure.

Kershaw and Peterson say that more laboratories are the answer to delays but who is going to fund them and will they permanently speed things up? Any new laboratory will be swamped within a few years.

It is impossible to eliminate traffic jams by building more roads because cars can be built quicker than roads. In traffic flow the inconvenience of traffic jams is part of the system and one has to learn to live with it. It is the only factor regulating the number of cars trying to use a particular road, because in engineering terms the system has no negative-feedback to make it stable. Likewise in C14 dating, samples will always be forthcoming to completely fill the counter-time available. The only brake on the number of samples offered for dating are the clients' ability to pay and to wait for the result.

Radiocarbon Laboratory  
Dept of Physical Chemistry  
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## CONFERENCES

### THE CAINOZOIC EVOLUTION OF CONTINENTAL SOUTHEAST AUSTRALIA

26-30 November 1980

Canberra College of Advanced Education

The following areas of study will be covered: stratigraphy and sedimentation; geomorphology; magnetism, tectonics and geophysics; Tertiary chronology; palaeontology; and economic aspects. Emphasis will be on the Tertiary, but some reference will be made to Mesozoic and Quaternary geology.

As well as the main paper sessions, a set of workshops will be held on Friday 28 November.

1. Mineralisation in Tertiary Sediments of SE Australia with particular reference to Uranium. Dr P.G. Moeskops, AMDEL, Flemington Street, Fernville, SA, 5252.
2. Tertiary Ostracods. Dr K. McKenzie, School of Applied Science, RCAE, PO Box 588, Wagga Wagga, NSW, 2650.
3. Tertiary Palynology and Stratigraphy. Drs W. Harris and H.A. Martin, Western Mining Corporation, 153 Greenhill Road, Parkside, SA, 5063.
4. Cainozoic Vertebrate Palaeontology. Dr T.H. Rich, National Museum of Victoria, 285-321 Russell Street, Melbourne, Victoria, 3000.
5. Palaeoceanography and Foraminiferal Biostratigraphy. Dr A.N. Carter, School of Applied Geology, UNSW, PO Box 1, Kensington, NSW, 2033.
6. Karst and the Cainozoic. Dr J.N. Jennings, Research School of Pacific Studies, ANU, PO Box 4, Canberra, ACT, 2600.
7. Cainozoic Coal, Dr H.J. Harrington, Bureau of Mineral Resources, PO Box 378, Canberra City, ACT, 2601.
8. Groundwater and the Cainozoic. Dr C. Lawrence, Department of Minerals and Energy, 107 Russell Street, Melbourne, Victoria, 3000.

For further information, contact the convenor of the relevant workshop. Registration forms are available from Graham Taylor, School of Applied Science, Canberra CAE, PO Box 1, Belconnen, ACT 2616.



CLIMANZ CONFERENCE

Climatic change of Australia and New Zealand - Late  
Quaternary events, the last 40,000 years

February 8-13, 1981

Howmans Gap National Fitness Camp, Falls Creek

For registration forms, contact Dr J.M. Bowler, CLIMANZ  
Organising Committee, Department of Biogeography and  
Geomorphology, Australian National University, PO Box 4,  
Canberra, ACT 2600.

STRESS AND SEISMICITY IN EASTERN AUSTRALIA:  
GEOLOGICAL AND ENGINEERING SIGNIFICANCE

The Geological Society (Victorian Division and Engineering  
Geology Group) and the Australian Geomechanics Society (Victorian  
Group) are jointly sponsoring a seminar on the above topic to be  
held in Melbourne on Wednesday 12 November 1980. Laboratory  
inspections are planned for 13 November 1980. The anticipated  
program comprises:

1. An outline of Quaternary stress/seismicity in Eastern  
Australia.
2. A review of the effect of stress and seismicity on  
engineering structures through a case history approach.
3. A review giving reference to requirements and recommendations  
for work in this field.

A detailed program and registration forms will be issued by  
June 1980. Interested parties can contact Mr J.R.O. Reid  
(Convenor), c/- M and MBW Engineering Geology Section, 331-333  
Burke Road, Gardiner, Victoria 3146.

## COASTAL QUATERNARY EXCURSIONS

During May 1980 two field excursions were conducted for those interested in Quaternary coastal sequences.

### ADELAIDE

The Quaternary Shorelines Committee of ANZAAS sponsored a full day trip to the area south of Adelaide including the Fleurieu Peninsula. Bob Bourman of the Department of Geography, Adelaide CAE, was the organiser and leader of this trip. He was assisted by Tony Milnes and John Firman. A number of points were considered on the excursion:

1. The relationship of Holocene St Kilda Formation to the underlying Glanville Formation of ? Last Interglacial age at the Dry Creek exposure north of Adelaide.
2. The evidence for stratigraphic discontinuities in Quaternary and Pliocene deposits to the south of Adelaide. Problems of interpreting shoreline features as mapped by W. Ward were discussed.
3. Development of fault-angle depressions and sedimentation in the Myponga Basin and upper Hindmarsh Valley were considered.
4. For those whose interest in glaciation was overwhelming, there was an opportunity to inspect terrain, striations and deposits of the vast Permian glaciation of the Fleurieu Peninsula.
5. Recent work by Bourman in the Victor Harbour area was investigated including visits to terraces along the lower Hindmarsh River and examination of marine deposits of possible equivalence to the Glanville Formation.

### PERTH

A very pleasant and stimulating excursion was conducted to the area south of Perth towards Bunbury, with Bill McArthur and George Kendrick as leaders. Points considered on this trip included:

1. The general sequence of Quaternary and Pliocene sediments of the Swan coastal plain.



2. Details of the section along Gordon Road near Mandurah. Here aeolian ridges are underlain by well-defined beach and nearshore shelly sand facies. A number of late Quaternary transgressions (possibly five) are recognised in the sequence along this road. Kendrick has undertaken extensive faunal collections of molluscs from pits in this area.
3. South of Mandurah towards Lake Preston several sections were examined showing late Quaternary deposits.
4. Bassendean dunes to landward of the calcareous ridge terrain were originally thought to be decalcified eolian terrain. They were observed along a drainage ditch west of Waroona. McArthur now feels that some of this unit was transported as siliceous sand.
5. The interrelationship of Pliocene beds near the Darling Scarp with Quaternary sequences to the west was also discussed.

Bruce Thom

HOLOCENE STUDIES AT PRINCESS CHARLOTTE BAY,  
NORTH QUEENSLAND

John Beaton

The southern end of Princess Charlotte Bay (east Cape York Peninsula) is a shallow and calm embayment where a mid-Holocene complex of parallel shell chenier/silt ridges are prograded across a broad supra-tidal saline plain which is bordered on its eastern side by the sandstone Bathurst range and on its western side by the intertidal mangrove community. Interspersed along the cheniers and ridges are Aboriginal shell middens and shell mounds which likely date to periods coincident with events in the progradation sequence of the cheniers/ridges.

In August-October 1980 interdisciplinary fieldwork will study evidence for the history of the coastal progradation and chenier formation, the history of shellfish and mangrove communities, and the relationships between these and the occupation of the archaeological sites. The program for 1980 includes archaeological excavations, morpho-stratigraphic studies of the Holocene plain, ecological mapping of the nearshore shellfish communities and the coastal vegetation communities and also a palynological study of vegetation communities extant during the period in question, i.e. the last 6000 years.

Participants in the study are John Chappell (ANU), John Beaton (ANU/Australian Institute of Aboriginal Studies), Ralf Buckley (ANU), Dermot Smyth (AIAS/CSIRO) and Eugene Wallensky (Australian Institute of Marine Science).

AIAS  
Canberra, ACT



## THE KUK PROJECT

Jack Golson

### I

The Kuk project is a program of archaeological and associated investigations into the history of agriculture in the New Guinea Highlands, which have been going on since 1972. Their focus is 100 hectares of swampland on Kuk Agricultural (formerly Tea) Research Station, specifically the less developed eastern half, at an altitude of 1650m in the upper Wahgi valley near Mount Hagen. Up to and including 1977 a team was in the field every year.

The following publications have charted progress, speculated on results and attempted to fit them into the wider picture.

1. Archaeology and agricultural history in the New Guinea Highlands. Pp.201-220 of G. de G. Sieveking, I.A. Longworth and K.E. Wilson (eds) ESSAYS IN ECONOMIC AND SOCIAL ARCHAEOLOGY. London, Duckworth, 1976 (after 1972 season)
2. Simple tools and complex technology: agriculture and agricultural implements in the New Guinea Highlands. Pp.154-61 of R.V.S. Wright (ed.) STONE TOOLS AS CULTURAL MARKERS: CHANGE, EVOLUTION AND COMPLEXITY. Canberra, Australian Institute of Aboriginal Studies, 1977 (after 1973 season)
3. The making of the New Guinea Highlands. Pp.45-56 of J.H. Winslow (ed.) THE MELANESIAN ENVIRONMENT: CHANGE AND DEVELOPMENT. Canberra, Australian National University Press, 1977 (after 1974 season)
4. (with P.J. Hughes) The appearance of plant and animal domestication in New Guinea. Pp.88-100 of J. Garanger (ed.) LA PREHISTOIRE OCEANIEENNE (symposium XXII at the IX Congress of the International Union of Pre- and Protohistoric Sciences, Nice, September 1976). Paris, Centre de la Recherche Scientifique, preprint, 1976 (after 1975 season). To be published, with slight revision, in French in JOURNAL DE LA SOCIETE DES OCEANISTES during 1980.
5. No room at the top: agricultural intensification in the New Guinea Highlands. Pp.601-38 of J. Allen, J. Golson and R. Jones (eds) SUNDA AND SAHUL: PREHISTORIC STUDIES IN SOUTHEAST ASIA, MELANESIA AND AUSTRALIA. London, Academic Press, 1977 (after 1976 season)

6. (with P.J. Hughes) Ditches before time. HEMISPHERE, vol.22, no.2, February 1977, pp.13-21 (a popular statement talking about the work until the end of the 1976 season)

Other publications have derived in part from the project:

1. R.J. Blong (1975) The Krakatoa myth and the New Guinea Highlands. JOURNAL OF THE POLYNESIAN SOCIETY, vol.84, pp.213-17
2. R.J. Blong (submitted) The time of darkness - legend and reality: investigations of a seventeenth century volcanic eruption in Papua New Guinea
3. E.C. Harris and P.J. Hughes (1978) An early agricultural system at Mugumamp Ridge, Western Highlands Province, Papua New Guinea. MANKIND, vol.12, no.4, pp.437-44
4. J.M. Powell, A. Kulunga, R. Moge, C. Pono and F. Zimike (1975) AGRICULTURAL TRADITIONS OF THE MOUNT HAGEN AREA. Port Moresby, University of Papua New Guinea, Department of Geography, Occasional Paper No.12, 68pp.
5. A. Steensberg (in press) NEW GUINEA GARDENS: A STUDY OF HUSBANDRY WITH PARALLELS IN PREHISTORIC EUROPE. London, Academic Press

The most up to date summary of the work at Kuk will appear as Chapter 4, New Guinea agricultural history: a case study, in a forthcoming volume called A HISTORY OF AGRICULTURE IN PAPUA NEW GUINEA being produced by the History Department, University of Papua New Guinea, for the Department of Primary Industry and edited by Donald Denoon and Catherine Snowden. This describes the results of fieldwork up to the end of 1977 and includes some new interpretations of the evidence.

## II

Large-scale fieldwork was halted in 1977 to allow systematic work to begin on putting in order and analysing the mass of data collected in previous field seasons. This work continues, though most of the principal investigators associated with the project - P.J. Hughes (Department of Prehistory, Research School of Pacific Studies, Australian National University), J.M. Powell (National Herbarium of New South Wales, Sydney) and R.J. Blong (School of Earth Sciences, Macquarie University) - have to do this in time outside their professional duties.

### 1. ETHNOGRAPHY: KUK COMMUNITY

Mr Paul Gorecki, Department of Anthropology, University of Sydney, is working with the Kuk community on studies of present and recent practices concerning gardening, housing, cooking and



pig husbandry. Besides providing a detailed description of the land use and development of a small Highlands community over a 20-year period, Gorecki's work will help in important ways in the interpretation of the archaeological evidence of gardening and habitation recovered from late levels of the Kuk swamp.

## 2. GEOMORPHOLOGY: KUK

One of the most important aspects of the investigations in the Kuk swamp has been the identification and interpretation of the different deposits laid down on top of one another in the swamp basin. The sediments forming the deposits are all washed in by creeks from the catchments of the swamp. We have claimed that the differences these deposits have from each other in character, thickness, extent and rate of accumulation reflect the different ways the parent material was eroded from the dry land of the catchments under different conditions, including various forms of land use.

Professor Frank Oldfield, Department of Geography, University of Liverpool, England, has been involved in developing a technique for determining the source in a catchment from which sediments deposited in a lake and swamp have been derived. This technique depends on the fact that different sorts of subsoil and the different soils developed on them commonly give different magnetic signals. The sediments derived from a particular source retains the characteristic signal, so that it is possible to determine from where in a catchment a type of sediment has come, and whether from the topsoil or the subsoil. The method seemed highly appropriate to the Kuk situation.

In July 1979 soil and subsoil samples were also taken in the catchments around Kuk swamp. A co-worker of Oldfield's, Dr Roy Thompson, who is a visitor in the Research School of Earth Sciences, Australian National University, during 1980, will take magnetic readings on all these samples and look for correlations between them. Variations in magnetic signal may not be found in such a geologically homogeneous environment as Kuk, but if they exist, they may help to improve our understanding of the conditions under which the different sediments in the Kuk swamp were derived from the surrounding dry land.

## 3. GEOMORPHOLOGY AND VEGETATION HISTORY: UPPER WAHGI

Amongst the results achieved by Oldfield from his analysis of cores taken from the sediments at the bottom of a number of Highlands lakes in 1973 was the demonstration that round about 250 (radiocarbon) years ago (250BP) there had been a consistent and significant increase in the rate of sediment deposition in the lakes, and also alteration in the nature of the sediment chemistry. Oldfield speculated that these changes were the result of changes in land use in the catchments of the lakes.

Significant changes took place in the Kuk swamp and on its northern margins at the same time. We are certain that we are dealing with events of the same date because both in Oldfield's

cores and the deposits at Kuk the point where the changes begin is marked by a thin layer of a distinctive volcanic ash, which fell over a large part of the Highlands at about 250BP. Russell Blong has shown that this ash, which he has named Tibito ash, comes from a major eruption on Long Island, off the north coast of Papua New Guinea near Madang.

The evidence of change at Kuk is of two types, one similar to Oldfield's, the other completely different.

1. We have striking indications of the beginning of increased erosion on the lower slopes of the steep Ep ridge which dominates the Kuk swamp to the north, in the form of massive deposition of sediment on the northern margins of the swamp.
2. Contemporary with this we have a series of changes in the use of the swamp basin itself:
  1. before 250BP all the swamp at the research site (100 hectares) was under drainage and cultivation. After that date drainage and cultivation were restricted to the southwestern third of the site, which is the part nearest to the higher, drier land and is itself easier to drain.
  2. before 250BP the field systems established on the drained swamp consisted of a loose grid of small flat-bottomed trenches articulating with larger ditches operating as drains. After that date the large ditches became more numerous and the grid of garden trenches much tighter, taking on a close resemblance to the chequer-board pattern of gardens and intervening trenches characteristic of sweet potato agriculture in the upper Wahgi today.
  3. before 250BP there were never houses associated with the gardens in the drained swamp. After that date house sites regularly appear: long ones with rounded ends and round ones, the latter identical in general size and internal arrangements with contemporary men's houses of the Hagen area, the former with contemporary women's houses in which pigs are stalled overnight. Like the traditional settlements of the Hagen area, the archaeological house sites are scattered singly or in small clusters through the gardens, not congregated in villages.

The garden and settlement types making their appearance at Kuk at 250BP (2 and 3 above) are so similar to those of the present day that we have explained them as marking the adoption of the sweet potato by Highlands farmers. The sweet potato is today the staple crop of Highlands agriculture, though it is a plant of tropical American ancestry and can only have been in New Guinea for a few hundred years at most. It has long been suggested that it would have recommended itself to high altitude farmers because it grows better and higher than food crops of the Indo-Pacific tropics like yam, taro and banana, which are staples at lower altitudes in New Guinea and are likely to have been so in the Highlands before the sweet potato made its appearance. In



addition the sweet potato is more tolerant than these other plants of naturally poor and agriculturally impoverished soils. All these qualities of the sweet potato, it has been suggested, would have allowed a spatial and temporal expansion of agriculture and settlement - spatial in the sense of expansion into higher altitudes and on to poorer soils, temporal in the sense of expansion of garden life by way of the sweet potato becoming a follow-up crop in a rotational cycle.

The archaeological/geomorphological work at Kuk and the geomorphological/palaeobotanical work of Oldfield is providing the first hard evidence in line with these theoretical predictions.

1. The increased rate of sediment deposition seen in Oldfield's cores could be the result of intensified land use such as might have followed the adoption of the sweet potato.
2. The massive deposition of sediment on the northern margins of the Kuk swamp perhaps reflects the first sustained use for agriculture of the steep slopes of Ep Ridge, made possible by the sweet potato.
3. The abandonment of two-thirds of the Kuk site for drainage and agriculture may have been due to the greater ability of the new crop to provide for people and their pigs from dry land cultivation.
4. The intensification of the drainage system on the swampland that continued in use, seen in a greater number of drainage channels and a closer mesh of garden trenches, is fully consistent with the cultivation of the sweet potato, a moisture-intolerant plant for which special provisions of this sort have to be made when it is grown in wet conditions.

Oldfield returned to the Highlands in 1979 to collect further core samples at his 1973 sites in order to study more closely the changes which he had recognised as taking place over the past 250 (radiocarbon) years. Ann O'Garra, the student associated with this work, was to have particular responsibility for the reconstruction of vegetation history over this period through the study of pollen grains in the lake sediments. Oldfield also sampled the top of the deposits at four additional lakes. Two of these are on Mt Ambra just beyond the head of the Kuk swamp, one of which had been previously cored by Dr Jocelyn Powell, another of whose sites, Draepi, on the Sepik-Wahgi divide at the foot of Mt Hagen, was also included in the program. The fourth site is the crater lake of Birip near Wapenamanda, to the west of Mt Hagen, previously worked by Dr John Flenley.

#### 4. SOIL FERTILITY AND AGRICULTURAL PRACTICES: KUK GARDENS

One of the features of Highlands agriculture is the ability of farmers to maintain sweet potato yields over many years from the same gardens before these are rested under long fallow. In particular we may point to the distinctive technique of digging a

grid of garden trenches, the spoil from which is spread over the intervening ground surface to form the garden soil in which the sweet potato tubers are planted. We have, however, no detailed study of the actual effects of any of the Hagen practices on soil fertility.

Golson was accompanied on his visit to Kuk in 1979 by M. Marc Latham, a soil scientist with the Noumea (New Caledonia) branch of the French Office de la Recherche Technique et Scientifique Outre-Mer, who was interested in this question. The purpose of his visit to Mt Hagen was to observe traditional garden practices, to record soil profiles on gardened land and to take samples from these profiles for analysis.

### III

There will be no archaeological fieldwork at Kuk during 1980 and attention will be given to the data already in hand, involving in the main further study of the archaeological evidence. An effort will, however, be made with Dr Jocelyn Powell to review the results of the various pieces of palaeobotanical work already carried out. These have included:

1. Pollen analysis of cores taken at Kuk and neighbouring sites as a basis for the reconstruction of vegetation history in the upper Wahgi valley and the recognition of the effects on the vegetation of millennia of agricultural operations.
2. Identification of seeds extracted from samples taken systematically from various places and various layers of the Kuk site with the aim of recognising from them changes in the ecology of the swamp corresponding to episodes in man's use and abandonment of it.
3. Identification of the timbers preserved in waterlogged conditions in the swamp, whether natural or worked into artifacts like digging sticks and wooden spades.

There will, however, be some fieldwork in 1980 in connection with the project. This will be done by Dr Tim Bayliss-Smith, Department of Geography, University of Cambridge, and will be directed to the study of wet cultivation of taro in the Highlands, since this is the crop most likely to have been grown in the drained gardens at Kuk and other upper Wahgi swamps in the past and likely to have been one of the staple foods before the arrival of the sweet potato. Bayliss-Smith has studied taro cultivation in the Pacific previously, and his New Guinea researches should allow him to make some estimate of the agricultural productivity of the swamp systems of the upper Wahgi using data that we have gained from the Kuk excavations and thus assess the levels of population that they are likely to have supported.

Department of Prehistory  
ANU

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## NEW BOOKS

Guide to the identification of teeth  
and some bones of native land  
mammals occurring in the extreme  
south west of Western Australia

by D. Merrilees and J.K. Porter

This book is the first serious attempt to provide a guide to the identification of the teeth and skeleton of Australian mammals. Although based on species recovered from excavations at Devil's Lair, Western Australia, it is of much broader application, since most of the genera and species included occur elsewhere as well. Photographic illustrations are used, with annotations indicating the key characteristics that distinguish each taxa from its relatives. Marsupials, rodents and introduced species are covered, and some extinct forms included. The guide can be obtained from The Bookshop, Western Australian Museum, Francis Street, Perth, WA, 6000. The price is \$19.60, including postage, within Australia.

## VICTORIA ARCHAEOLOGICAL SURVEY PUBLICATIONS

The Victoria Archaeological Survey issues a series of publications, including RECORDS, MEMOIRS, special publications, pamphlets and posters. A list of current publications and prices is available from The Librarian, Victoria Archaeological Survey, 29/31 Victoria Avenue, Albert Park, Victoria 3206. The most recent publication is 'A preliminary investigation of Aboriginal Mounds in North-western Victoria', Records No.9.

This volume describes the results of research carried out on Aboriginal earthen mounds in the Nyah-Wood Wood area along the Murray River during the summer of 1977/78. The results indicate that the recent Aboriginal population of this area was probably leading a far more sedentary way of life than was hitherto thought.

## ANZAAS QUATERNARY SHORELINES REPORT

1979-1980

Each year now for over 20 years representatives of each state have compiled reports on activities in their area related to Quaternary shorelines research. This year there is a notable omission. About the time I was communicating with representatives, Edmund Gill, a founding father of the committee, former secretary and Victorian representative, became ill. He felt the need to resign from most positions including that of Victorian representative. Unfortunately, a replacement for Edmund has yet to be found; in fact I wonder if such is possible.

THIS ISSUE OF THE QUATERNARY SHORELINES REPORT IS DEDICATED TO EDMUND GILL. For years he has encouraged many to study shorelines. His enthusiasm and dedication to his chosen science will live long in my memory and I'm sure in the memories of others. As our international representative on several INQUA committees, he has tirelessly pushed the Australian evidence before the world. On behalf of all Quaternarists, Edmund, I would like to wish you a speedy recovery.



## NEW ZEALAND

New Zealand research on Quaternary Shorelines published during the last couple of years continues to emphasise:

1. modern coastal processes and changes;
2. the importance of Quaternary tectonic deformation on many parts of the coast; and
3. the significance and influence of the work and ideas of Mr J.C. Schofield (NZ Geological Survey, Otara, Auckland) on Holocene sea level changes.

### HOLOCENE SHORELINES AND SEA LEVEL

It is now 20 years since Schofield (1960) published his paper on 'Sea level fluctuations during the last 4,000 years as recorded by a chenier plain, Firth of Thames, New Zealand'. This benchmark paper, and its successors by the same author (mentioned in earlier reports of the ANZAAS Quaternary Shoreline Committee) has had an enormous impact on students of shore and sea level history both nationally and internationally. In a recent overview on the problems of chenier genesis and terminology Otvos and Price (1979) note that the Firth of Thames shell ridges and mud flats provide one of three known bayhead chenier plains that fits their strict definition (the others are Broad Sound, Australia and Colorado Delta, Gulf of California). The Firth of Thames cheniers are in the western fault-angle part of the Hauraki Depression, now regarded as an active rift structure (comparable to continental rifts) which was formed after the collision of the India and Pacific plates. The Hauraki Depression is 20-30km wide, at least 220km long, and contains a maximum thickness of about 3km of Quaternary and Tertiary sediments (Hochstein and Nixon 1979).

Garrick (1979) describes a suite of gravel ridges near Te Araroa, East Cape where dated shell samples show a consistent progradation rate of 0.45m per year for the first 320m. Projection inland of this rate 'suggests an age of 3850 years for the oldest ridge, which compares with 3900 years for the oldest ridge in the more stable region of the Firth of Thames'. Garrick compares the Te Araroa and Firth of Thames ridge systems and suggests an uplift rate of 1.5mm per year for the Te Araroa region. The succession of ridges are broken by at least two periods of coastal revision.

Marks and Nelson (1979) report evidence from Omaro Spit, Coromandel Peninsula, that indicates local sea level was at least 2m higher than present some 4000-5000 years ago and that it reached its modern level about 1000 years ago, though they have no local radiometric dates to confirm the timing. They accept

Schofield's postglacial high sea level and suggest that the bulk of the dune ridge system developed in response to a 2-3m eustatic lowering of sea level since 4000-5000 years ago. Their evidence could also 'be interpreted as indicating a Holocene sea level up to 4-5m above present, so that either storm deposits have contributed significantly to the construction of the barrier spit or as much as 2-3m of this height may be due to tectonic uplift'. Progradation of the Omaro barrier was interrupted by an important period of coastal erosion during a temporary rise in sea level immediately before deposition of a layer of 2000 year old sea-rafted Leigh Pumice.

A morphostratigraphic investigation by Hesp and Shepherd (1978) in the lower Manawatu Valley, southern North Island, 'offers no support for the idea that sea levels have been appreciably higher than at present during the Holocene'. Radiocarbon dating of estuarine mollusc shells (6330±70BP) does provide evidence that box-shaped valleys developed in a last interglacial marine terrace became estuaries during the postglacial transgression, but assuming a long term constant uplift rate of 0.35m per 1000 years the top of the estuarine beds now at a height of 1.1m above mean sea level 'will have been uplifted by about 2.2m since deposition'. In the light of their work Hesp and Shepherd re-examined the Holocene marine cliff and gravel beach ridges southwards from the Otaki River described by Te Punga (1962) as providing evidence for a +3m Holocene sea level: 'This evidence invalidates Te Punga's (1962) claim that Holocene sea levels have been higher than present in this area' (Hesp and Shepherd 1978).

#### LAST GLACIAL - HOLOCENE TRANSGRESSION

Keyes and Froggatt (1978) report a moa bone (tibia) dredged from the sea floor of Cook Strait in depths of 119-128m. Based on the calcareous silty matrix they considered the bone to have come from an estuarine or marine deposit and not terrestrial swamp, and presumed the age of the bone to be late Pleistocene. 'During this last glacial period of low sea level (some 105-135m lower than present) the shoreline extended considerably westward, linking the North and South Islands before the creation of Cook Strait...with the gradual post-glacial rise in sea level and the formation of Cook Strait these Pleistocene deposits have become subject to marine scouring exposing their fossil remains on the sea bed' (Keys and Froggatt 1978).

On the west coast South Island continental shelf, between Karamea and Waiho River, Norris (1978) identified a number of submerged shorelines that cluster at about 41, 50-58, 70-80 and 100-110m, the 70-80m shoreline often overlapping with the 67-82m shorelines. After applying the Cullen (1967) and Curray (1966) sea level curves to the submerged shorelines (presumed to be younger than 20,000 years) and correcting for an assumed 25m of downwarping spread evenly over the past 20,000 years, Norris lists the apparent depths and ages of the shorelines: 18-23m (7500-8000BP); 41m (8500BP); 50-58m (9800-10,200BP); 67-80m (10,400-11,000BP); 100-110m (14,000-16,000BP). He notes: 'Until the supposed submerged and buried beaches are dated by Carbon-14



or by other means, these ages should be considered provisional, and use of them to determine rates of sedimentation and canyon erosion would be speculative. It is also worth noting that elevated terraces on land indicate late Quaternary uplift'.

#### PLEISTOCENE SHORELINES AND SEA LEVELS

Around Raglan Harbour on the west coast, North Island, Sherwood and Nelson (1979) found a large proportion of the tidal flats are simply sediment-covered rock platforms. The platforms occur at two distinct levels. The higher and modern platform has been cut during the last 5000 years at a rate of up to 2cm per year. The lower, at about -10m, is more extensive. 'If cutting rates were similar to those suggested for the modern shore platform then it is necessary to invoke a stable sea level for a period of about 25,000 years. On this basis and considering the elevation of the platform, it is possible that the lower platform was cut during the intertidal high sea level stand from 85,000 to 60,000 years ago (Chappell 1974)'.

North of Raglan Harbour on the northern side of the Waikato River mouth open cast mining has exposed the sedimentary structures in Late Quaternary ironsand deposits considered by Christie (1979) to have an aeolian origin. 'The aeolian sand is considered to represent three or four dune stages. Water-laid sand of interdune stream-lake or beach origin makes up a small proportion of the Waiuku Blacksand Member and separates two of the dune stages. If this sand is of beach origin it may record 120,000-125,000 year and 105,000 year sea-level maxima and imply an uplift rate of 0.3mm per year for the mine site area'.

On most parts of the southeast coast of the North Island Ghani (1978) identified four benches of the Last Interglacial and the Present Interglacial bench. Inferred ages for the back of the benches are 125,000; 100,000; 84,000; 80,000; and 6000 years. The district has had an erogenic phase of folding and intense uplift over the last 200,000 years. On the marine benches uplift rates range from 0.75 to 4m per thousand years for the growing anticlines and from 0.5 to 2.2m per thousand years for the growing synclines.

Two other studies have been completed on the area to the west of where Ghani (1978) worked. Heine (1979) described a number of planation surfaces around Wellington City and related them to marine terraces on the outer (western) coast. Many of the planation surfaces are cut into Late Quaternary deposits which are found up to 61m, but higher terraces are identified up to 177m cut into basement greywacke. 'The data suggest a relatively stable Late Quaternary period between the earlier major folding along the Wellington Fault which forms the basin, and recent tectonic movements'. Williams (1978) investigated the surfaces on Mana Island which is capped by the Mana Surface sloping from 122m to 80m, at 2 degrees. The surface is considered to be a marine abrasion platform. Below the Mana Surface seven marine benches and gravel terraces have restricted distribution. Williams considers these benches and terraces to have formed during successive interglacials. No evidence of tilt on these levels was detected.

## RECENT COASTAL CHANGES AND PROCESSES

Pain (1979) recently obtained radiocarbon dates suggesting that Maori occupation of coastal areas near Aotea and Kawhia Harbours initiated aeolian erosion of previously stable dune systems during the last 600-800 years. This erosion led to the formation of the most recent sand dunes. McFadgen and Challis (1979) describe three belts of dune sand on Parapara Spit, Golden Bay, each representing a phase of accumulation since 1800 years ago.

A most comprehensive inventory of coastal changes in historic times at 471 localities around the entire New Zealand coast was prepared by Gibb (1978). Along depositional shorelines erosion and accretion generally occur at 0.5 to 4m per year (maximum erosion 25m per year; maximum accretion 69m per year). A number of other studies on short-term beach changes have been completed (e.g. Pickrill 1979; Harray and Healy 1978; Matthews 1979). Also of significance is a review of ocean wave characteristics around New Zealand (Pickrill and Mitchell 1979) and storm surges (Heath 1979).

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## PAPUA NEW GUINEA

DR M.A. GHANI (Dept of Geology, University of Papua New Guinea)

The project, 'Quaternary Geology and Tectonics of Papua New Guinea' has been continuing from 1975 with the aim of interpreting vertical crustal movement within the boundary of Indian and Pacific plates. The program of collecting uplifted shoreline data and coral samples has been extended to Wewak, Aitape and Vanimo.

Uplifted shoreline maps of Fangalawa and Konos, New Ireland, have been prepared from field data and aerial photographs at a scale of 1:100,000. A flight of 28 coral terraces are preserved on the eastern flank of Lelet Plateau. The uplift pattern map of parts of New Ireland will be completed by June 1980. A paper is in preparation for publication and oral presentation to the 26th International Geological Congress, Paris.

Ghani, M.A. 1980 Uplifted shorelines and geodynamics of New Ireland, Papua New Guinea. Abstract only in the 26th International Geological Congress, Paris

DR C.F. PAIN (Dept of Geography, University of New South Wales)

Dr Pain left UPNG by the middle of 1979 but is continuing with his research interests in this country. His project, 'Geomorphology of the Port Moresby coastline' has been continuing since the beginning of 1978. He has mapped a small inlet at the mouth of the Vaihua River south of Port Moresby showing inner sandpit (6m high), fossil beach (6-7m high), coral reef and outer sandpit (3.5-4.5m high). He infers that the inner sandpit is related to the eustatic maximum of 125,000 and the outer sandpit to that of 5000-6000 years. Some material will be dated in future.

Pain, C.F. and P. Swadling 1980 Sea-level changes, coastal landforms and human occupation near Port Moresby - a pilot study. Submitted for publication in SCIENCE IN NEW GUINEA.

MR A.P. SPENCELEY (Dept of Geography, University of Papua New Guinea)

His project 'Evolution of Mangroves in Central Province, PNG', has been continuing with the laboratory analysis of samples. He has been investigating the development of the mangrove swamp and complex sand barrier systems between Marshall Lagoon and Hula on the south Papuan coastline. The area is distinctive not only because of a variety of mangrove swamp characteristics that are displayed there, but also because it contains a series of parabolic dunes which are not found elsewhere in the country. To date, the main geomorphological



environments have been identified. Three wood samples found on the spit at Hood Lagoon are in the process of identification and radiocarbon dating.

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#### QUEENSLAND

A large proportion of research relevant to Quaternary shorelines in Queensland is being undertaken on the Great Barrier Reef, with further work carried out in Moreton Bay, Fraser Island and the Flinders Islands of Princess Charlotte Bay.

UNIVERSITY OF QUEENSLAND (Dept of Geology and Mineralogy)

#### Research activities

The research group is concerned with two main areas of study, namely -

1. Sedimentological and geophysical investigations within the Great Barrier Reef Province.
2. Holocene sedimentation and shorelines progradation within Moreton Bay.

Dr Orme and Professor Sargent conducted a very successful three-week trip in November 1979, covering the continental shelf area from Cape Melville to Cairns. Continuous high resolution seismic profiles were determined along 780km of ship's tracks. This research project 'An investigation of the geological evolution of the northern Great Barrier Reef using high resolution seismic methods' is ARGC funded.

Dr Flood continued his study of the evolution of reef-top sediments and sand cay erosion within the reefs of the Capricorn-Bunker Groups of the southern Great Barrier Reef.

Mr Harjanto has completed a draft MS of his study of the evolution of Lady Elliott Reef and will be submitting it for an MSc degree.

Dr Flood has completed his study of Holocene sedimentation within Deception Bay (Moreton Bay). Seven radiocarbon dates obtained from shell material within a sequence of beach ridges provides a temporal framework of sea-level fluctuations covering the past 5000 years.

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- Orme, G.R. and P.G. Flood 1980 Sedimentation in the Great Barrier Reef Province, adjacent bays and estuaries. IN J. Stephenson and R. Henderson (eds) GEOLOGY AND GEOPHYSICS OF NORTH EASTERN AUSTRALIA. Geol. Soc. Aust. Qd Div.

## UNIVERSITY OF QUEENSLAND (Dept of Geography)

In June 1979 two literary studies in coastal geomorphology were prepared by Philippa Sales of the Geography Department, University of Queensland, St Lucia. They were entitled 'Post-war research on the coastal geomorphology of Queensland, Australia' and 'East coast of Australia coastal dunes - a literary study'.

A review of available literature and reference lists are presented. The review clearly shows the need for coordinated research to prevent duplication and allow for general conclusions to be reached; a need to publish the findings; and most of all, the need to investigate the relatively wide open field of coastal morphology.

## Geological Survey of Queensland

The Survey has an increasing interest in Quaternary marine deposits (see Hekel 1980 for details). Major areas of interest are Moreton Bay, Fraser Island and the Great Barrier Reef. In Moreton Bay modern sea level was achieved about 6000 yrs BP (Smith 1979) but small changes of sea level indicated by beach ridges, stranded supratidal flats, corals in situ, pumice and shelly beaches indicate small fluctuations subsequently (Hekel et al. 1979; Jones et al. 1979). Drilling in the Bay has confirmed a maximum of 17.4m of Holocene sediments overlying relict Pleistocene marine sediments in places (Jones and Hekel 1979). A buried strandline at c.4m below Low Water Datum has been detected (Smith 1979). Revised ages for Fraser Island sand bodies have



been provided by new C14 dates by Grimes (1979). Reconnaissance descriptions of a number of islands on the northern Great Barrier Reef are given by Hekel (1979). A number of features have been related to higher Holocene sea levels and warping of relatively recent age suggested in the Torres Strait region. The Survey has also been engaged in continuous seismic survey with James Cook University between Cairns and Townsville (in 1978) and in the Townsville region (in 1979).

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#### AUSTRALIAN INSTITUTE OF MARINE SCIENCE-AUSTRALIAN NATIONAL UNIVERSITY

Coring into the extensive sand barrier-mangrove complex on the northern end of Hinchinbrook Island by E.G. Rhodes (AIMS) has located an earlier Pleistocene barrier beneath the present Holocene dunes of Ramsay Bay. Dr J. Chappell (ANU) working from AIMS is carrying out a stable isotope study of palaeoclimatic and

environmental geochemistry of the Great Barrier Reef area. Dr Chappell has also been investigating emerged fringing reefs on the Flinders Islands in Princess Charlotte Bay for which radiocarbon ages of about 6000 yrs BP have been established.

#### JAMES COOK UNIVERSITY OF NORTH QUEENSLAND

Continuous seismic reflection profiling of the inner shelf is being conducted by the Queensland Geological Survey in conjunction with Dr D. Johnson (Geology) and Associate Professor D. Hopley (Geography). It is hoped to identify Pleistocene low sea level drainage patterns and possible shorelines in this survey.

Associate Professor Hopley is continuing his work on the age of reef surfaces of the Great Barrier Reef and is extending this research with a deeper drilling program which is recovering core material down to the Holocene-Pleistocene boundary. The program has established that reef top ages in the Cairns to Townsville area are no greater than 3000 yrs old, between 2000 and 3000 years younger than most of the Great Barrier Reef. Although a number of factors are involved, considerable shelf warping, probably incorporating a significant hydro-isostatic component, is indicated in the late Quaternary. Mr N. Harvey, working with the Bureau of Mineral Resources, has produced considerable data on the depth and influence of the Holocene-Pleistocene discontinuity beneath reefs of the Bunker-Capricorn Group (Harvey et al. 1978, 1979).

Belperio (1979) has contested the evidence for higher Holocene sea levels in the Townsville area. However this has been disputed by Hopley (1980) who has presented a number of new  $^{14}\text{C}$  dates for emerged features including a date of  $5530 \pm 130$  yrs BP for an emerged (+1m) reef on Rattlesnake Island (GaK-7688). Early attainment of modern sea level (before 6000 years BP) and varying degrees of emergenc from 0 to 4m appears to typify much of the Queensland coastline.

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- Harvey, N., P.J. Davies and J.E. Marshall 1978 Shallow reef structure: southern Great Barrier Reef. B.M.R. J. AUSTR. GEOL. AND GEOPHYS. REC. 1978/96
- Harvey, N., P.J. Davies and J.F. Marshall 1979 Seismic refraction, a tool for studying coral reef growth. B.M.R. J. AUSTR. GEOL. AND GEOPHYS. 4



Hopley, D. 1980 Mid Holocene sea levels along the coastal plain of the Great Barrier Reef Province: a discussion. MAR. GEOL. 35:M1-M9

#### BUREAU OF MINERAL RESOURCES

The BMR team led by Dr P.J. Davies has continued its work on Holocene reef growth including its relationship to the postglacial transgression in the Bunker-Capricorn Group of reefs (Davies and Marshall 1979). This work has now been extended into the Central Great Barrier Reef region.

#### PUBLICATION

Davies, P.J. and J.F. Marshall 1979 Aspects of Holocene reef growth - substrate age and accretion rate. SEARCH 10:276-79

David Hopley  
Department of Geography  
James Cook University of  
North Queensland

#### SOUTH AUSTRALIA

1. Von Der Borch, C.C. and M. Altmann 1979 Holocene stratigraphy and evolution of the Cooke Plains Embayment, a former extension of Lake Alexandrina, South Australia. TRANS. R. SOC. S. AUST. 103(3):67-78

The Cooke Plains Embayment occupies an emergent area that was recently inundated by Lake Alexandrina. The embayment is underlain by a Holocene sedimentary succession several metres thick, the stratigraphy of which reflects some aspects of the late Holocene climatic and other changes in the vicinity of the River Murray delta system. The most likely cause of the late Holocene expansion of the lake system is considered to have been increased inflow to the lake from the River Murray, during the worldwide 'pluvial' period that occurred 5000-8000 years ago. A contributing cause may also have been the peak of the Holocene marine transgression which is dated in southern Australia at around 6000 years ago. The slightly higher than present sea-level stand may have backed up lake waters by raising base level, with a consequent rise in groundwater table. Some direct inflow of ocean water may have also taken place at this time. Subsequent to the high lake stand, increased aridity combined with a slight sea-level fall lowered lake level approximately to its present

situation. The palaeoclimatic events deduced from the stratigraphy of the Cooke Plains Embayment are consistent with those proposed by other workers from stratigraphic evidence in lakes of western Victoria.

2. Daily, B., A.R. Milnes, C.R. Twidale and Jennifer A. Bourne 1979 Geology and geomorphology. In M.J. Tyler, C.R. Twidale and J.K. Ling (eds) NATURAL HISTORY OF KANGAROO ISLAND

Comments are made on early work of Bauer on Kangaroo Island, who postulated a late Pliocene sea level at the present altitude of 122m and five Pleistocene to Recent shorelines between 52m and 3m above present sea level. Evidence for the lowest two levels is reasonably well substantiated, for former shorelines at 3.5m and 6.8m, but the marine origin of the higher levels at 15-23m, 30-34m, and 43-52m is questioned.

3. D. Schwebel, formerly of the School of Earth Sciences, Flinders University, has completed his PhD on the 'Quaternary stratigraphy of the south east of Australia'.
4. Cann, J.H. 1978 An exposed reference section for the Glanville Formation. QUARTERLY GEOLOGY NOTES, GEOL. SURV. S. AUST. 65:2-4

The excavation of a trench on the western margin of a new salt crystallisation pan at Dry Creek exposed up to 0.45m of consolidated Glanville Formation. Previously this formation had only been known from a now submerged dock and from drill holes. The Glanville Formation overlies the Pleistocene Hindmarsh Clay and its calcreted surface is overlain by the Holocene St Kilda Formation. The excavated site is proposed as a reference section for the Glanville Formation. The area is totally accessible during summer. The Glanville Formation is characterised by the bivalves Anadara trapezia (Deshayes) and Pinctada carchariarium Jameson and by the foraminifer Marginopera vertebralis Blainville.

5. Hails, J.R., V.A. Gostin and G.E. Sargent 1980 The significance of the submarine geology of Upper Spencer Gulf, South Australia to environmental decision-making. SEARCH 11(4):115-6

A combined geophysical and geological study of upper Spencer Gulf, South Australia, has revealed a sequence of stiff, alluvial clays and gravels overlain by Pleistocene estuarine sediments, which is only partially mantled by Holocene (Recent) shelly sands. Removal of, or damage to, sea grass banks or mangroves covering these sands will interrupt shoreline equilibrium. Pollutants accidentally discharged by coastal industries will remain in the upper Gulf because of restricted water circulation and the presence of clays.



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## WESTERN AUSTRALIA

### GEOLOGICAL SURVEY OF WESTERN AUSTRALIA

John Baxter is commencing a project with George Kendrick (WA Museum) and Roger Hamilton (Western Mining) on the correlation of a shoreline sequence at the foot of the Gingin Scarp that has been assigned a Pliocene age by George Kendrick on the basis of its contained shelly fossils. This deposit appears to be equivalent to the heavy mineral-bearing shoreline deposits at Eneabba and Yoganup (Baxter 1977).

Phillip Playford has continued to work on the elevated shorelines on Rottnest Island. The elevations of these shorelines are being determined by precise levelling, and this survey work will be extended to other Quaternary and late Tertiary shorelines between Dongara and the south coast. In this way it should be possible to determine whether any differential uplift or warping as a result of Quaternary tectonism was involved in emergence of these shorelines.

### WESTERN AUSTRALIAN MUSEUM

Over the past year (1979-80), George Kendrick has been examining an extensive collection of Late Quaternary fossil material from emergent shoreline and other deposits around Shark Bay. A report on Pleistocene and Holocene faunas and palaeoenvironmental conclusions is being prepared for submission to the Geological Survey of Western Australia.

From a study of subsurface marine deposits in the Perth district, sampled from water bores, evidence for a Pliocene age for one deposit has been obtained and an approximate position of an Early Pleistocene transgressive shoreline deduced. A paper has been submitted for publication.

Collections of fossils, mostly molluscs, from what are thought to be late-Middle Pleistocene littoral deposits, have been obtained from the Mandurah and Vasse districts, Perth Basin.

An Early Pleistocene Potorous (Potoroo or Rat Kangaroo) of uncertain species from water bore samples from Jandakot, near Perth, has been recognised by Jane Balme. This specimen is a single tooth, broken into two parts and recovered in separate sludge samples. The finder, Miss V.A. Ryland, recognised the two fragments, which fitted together perfectly. This appears to be the oldest marsupial fossil on record from Western Australia. A paper has been submitted for publication.

Alex Baynes' PhD thesis on an analysis of a Late Quaternary mammal fauna from Hastings Cave, Jurien, has been passed by the University of Western Australia. Publication is envisaged.

UNIVERSITY OF WESTERN AUSTRALIA (Department of Geology)

Research being carried out by Brian Logan, Ray Brown and several research students involves studies of Quaternary shoreline histories in a number of areas on the west coast. Three fields of study are involved, each impinging on the coastal zones: 1) evaporite and carbonate sedimentation, 2) Holocene sedimentation studies of the continental shelf, and 3) estuarine and embayment sedimentation studies.

The first group of studies is largely centred at Lake MacLeod, near Carnarvon, but has recently been concerned with smaller coastal lakes further south; stratigraphic studies in these projects are generating a story of evaporite-basin evolution within a pattern of Quaternary sealevel changes. In the second group, a sedimentation study of inshore sections of the Rottne Shelf, near Perth, involves the interaction of the Holocene sedimentation history, with aspects of earlier, Quaternary shoreline morphology. A second project, centred on the Abrolhos Islands, considers Quaternary shoreline studies as part of an overall study of reefal sedimentation. The group of estuarine and embayment studies has been concerned with evolution of inlets, tidal flats and embayments in the course of Holocene sealevel changes and, where suitable stratigraphic records persist, in the Pleistocene; recently, projects have been finished in the Geographe Bay, Peel Inlet and Cockburn Sound areas.

CSIRO LAND RESOURCES MANAGEMENT

During the past few years Bill McArthur has mapped and described the landforms and soils in the coastal zone of southwestern Australia. The work provided information for planning authorities, but has also led to an understanding of the principals of landscape development. The coastal zone is composed of Tamala Limestone partially covered by Holocene dunes. Marine deposits, which elsewhere occur as bands in the Tamala Limestone, outcrop over large areas. The Holocene dunes have accumulated in at least four phases, which can be recognised by their morphology and soil-profile development.

PUBLICATIONS

Baxter, J.L. 1977 The heavy mineral sands of Western Australia. WEST. AUST. GEOL. SURVEY MINERAL RESOURCES BULL. 10

McArthur, W.M. and G.A. Bartle 1980 Land forms and soils as a basis for urban planning in the Perth Metropolitan Northwest Corridor. CSIRO DIV. L.R.M., MANAGEMENT SERIES NO.5

McArthur, W.M. and G.A. Bartle 1980 Soils and land use planning in the Mandurah-Bunbury coastal zone, W.A. CSIRO DIV. L.R.M., MANAGEMENT SERIES NO.6

McArthur, W.M. and G.A. Bartle (in prep.) Land forms, soils and



vegetation as a basis for management studies on Garden Island. CSIRO DIV. L.R.M. MANAGEMENT SERIES

Merrilees, D. 1979 Prehistoric rock wallabies (Marsupialia, Macropodidae, Petrogale) in the far south-west of Western Australia. JOUR. ROYAL SOC. WEST. AUSTRALIA 61:73-96

Merrilees, D. 1979 The prehistoric environment in Western Australia. JOUR. ROYAL SOC. WEST. AUSTRALIA 62:109-28

Merrilees, D. and J.K. Porter 1979 Guide to the identification of teeth and some bones of native land mammals occurring in the extreme southwest of Western Australia. WESTERN AUSTRALIAN MUSEUM, 152pp. This work consists largely of beautifully photographed, well labelled photographs of skeletal material representing native and introduced mammals. Available from the publisher, price \$16.95

Porter, J.K. 1979 Vertebrate remains from a stratified Holocene deposit in Skull Cave, Western Australia. JOUR. ROYAL SOC. WEST. AUSTRALIA 61:109-17

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#### TASMANIA

In northwestern Tasmania research has been continued on the peat deposits and spring mound sediments that overlie the Mella marine sands which extend to at least 13m above present HWM. A C14 assay of 47,500  $\pm$  2700BP/-2600BP (GrN-7481) (Van de Geer et al. 1979) on a tree stump in growth position in a palaeosol halfway through a sectioned spring mound points to an age of at least 100,000 years BP for the marine sands. Pollen analysis of the freshwater peats has revealed a long (80-100 KA) sequence of glacial and Holocene vegetation changes for the Mella area of Mowbray Swamp. The marine sand plains of northwestern Tasmania thus appear to be of Last Interglacial age and no older marine sediments are known.

In northeastern Tasmania work on the coastal marine sand plains, that stratigraphically underlie the linear and lunette dunes and extend up to 32m above present HWM, has been continued and a Last Interglacial age is indicated. Higher marine surfaces have been recorded by Bowden at Rockbank where the marine sediments contain abundant siliceous sponge spicules and form two broad terraces at 49m and 71m. These deposits belong to earlier interglacial high sea levels (possibly isotope stages 7 and 9 of Shackleton and Opdyke, 1973) and together with the 32m height of the Last Interglacial age marine deposits indicate that it is

necessary to consider that Tasmania has been undergoing tectonic uplift at least during the middle and late Quaternary.

#### PUBLICATIONS

Bowden, A.R. 1978 Geomorphic perspective on shallow groundwater potential, coastal north-eastern Tasmania. AUSTR. WATER RESOURCES COUNCIL Tech. Paper No.36, 84pp.

Van de Geer, G., E.A. Colhoun and A.R. Bowden 1979 Evidence and problems of interglacial marine deposits in Tasmania. GEOL. EN MIJNBOUW 58(1):29-32

E. Colhoun  
Department of Geography  
University of Tasmania

#### NORTHERN TERRITORY

##### PUBLICATION

Clarke, M.F., R.J. Wasson and M.A.J. Williams 1979 Point Stuart Chenier and Holocene sea levels in Northern Australia. SEARCH 10:90-92

#### NEW SOUTH WALES

##### UNIVERSITY OF NEWCASTLE (Department of Geography)

1. Mr Wally Jenks is completing his doctoral research program which incorporates analysis of cross-sectional and spatial morphology of tidal distributary channels of the Manning River delta, New South Wales. Emphasis is placed upon the hydraulic geometry of the estuarine streams and the topologic properties of the anastomosed portion of the distributary network. Background to the study includes consideration of river flow, tidal parameters and Quaternary delta morphogenesis. Surface morphology is considered in terms of wave energy and states of momentum balance existing between runoff and tidal energy regimes.

2. Dr Rod Kidd continues to research the morphology and morphometry of supratidal conglomerate shore platforms south of Newcastle. Field evidence indicates strongly that contemporary abrasion is of little consequence despite the potential abundance of suitable tools. Quarrying is confined to intermittent attack along the seaward margins of the platforms. Water layer



weathering is lowering rearward areas of the platforms and, allied with subaerial weathering and mass wasting, promotes platform extension via cliff recession. Fastest rates of cliff recession appear to occur at exposed sites where weathering is probably more intense due to greater accretion of seaspray.

3. Fortnightly surveying of Newcastle's metropolitan beaches by Kidd in conjunction with Newcastle City Council continues. Strong accretional trends dominate all transect records since the project commenced in December 1978, reflecting a scarcity of storm wave events and augmented by the very persistent northeast seabreeze conditions since September 1979. Changes in beach morphology and sand volumes are now being correlated with the variations in incident levels of wave power derived from a Maritime Services Board deepwater waverider buoy record. It is also planned to place contemporary beach changes in a broader context by reference to historical maps and photographs.

#### PUBLICATIONS

Jenks, W.N. 1979 Topologic and geometric properties of the anastomosed estuarine network in the Manning Delta, N.S.W. NEWCASTLE STUDIES IN GEOGRAPHY, Dept of Geography, University of Newcastle, NSW, pp.109-16

Kidd, R.W. 1979 Shore platforms near Catherine Hill Bay. NEWCASTLE STUDIES IN GEOGRAPHY, Dept of Geography, University of Newcastle, NSW, pp.135-40

R.W. Kidd

UNIVERSITY OF WOLLONGONG (Departments of Geology and Geography)

#### PUBLICATIONS

Jones, B.G., R.W. Young and I.G. Eliot 1979 Stratigraphy and chronology of receding barrier-beach deposits on the northern Illawarra coast of New South Wales. GEOL. SOC. AUST. J. 26:255-64

Wilson, M.G.A., R.W. Young, G.C. Nanson, I.G. Eliot, D.J. Clarke and J.F. Bywater 1979 Wallaga Lake: its condition, use and development potential. University of Wollongong, 128pp. (This report includes a section on distinguishing middens from beach deposits.)

#### GEOLOGICAL SURVEY OF NEW SOUTH WALES

Most of the projects listed below have been carried out by the Marine Geology Sub-section jointly with the Coastal Engineering Branch of the Department of Public Works. Personnel include Dr P. Roy, Mr A. Stephens and Mr E. McLean.

1. Coffs Harbour. Detailed surface sediment sampling, shallow offshore coring, onshore augering and land mapping provide the basis for constructing an evolutionary model for Holocene deposition in the Coffs Harbour area. Holocene barriers decrease in size from south to north and onlap estuarine clays of Pleistocene (Late Interglacial?) age. The Pleistocene barriers that these clays accumulated behind have been destroyed by marine erosion, presumably in Pleistocene times. Historical data suggest that the construction of the Coffs Harbour breakwaters have interfered with northward littoral drift with the result that sand has accumulated on Boambee Beach to the south and also inside the harbour. Beaches to the north are starved of sediment although, in at least one case, coarse inner shelf sand has been reworked and transported onshore. C14 dates on three shell samples from 1m below the sea bed on the inner shelf range from 2600 to 14,000 yrs BP.

2. Forster-Tuncurry Area. Surface sediment sampling and bathymetry in the area offshore from Nine Mile and Seven Mile Beaches on either side of Cape Hawke have delineated two contrasting embayment types. Nine Mile Beach embayment in the north has a wide Holocene barrier and shallow inner shelf; Seven Mile Beach embayment to the south has a narrow barrier onlapping Pleistocene deposits and a deep inner shelf. The area off the northern side of Cape Hawke is possibly a zone of sediment accumulation. Littoral drift is towards the north and bypasses Cape Hawke; the northern embayment has acted as a sediment trap in the past.

Radiocarbon dates from a line of drill holes across the Tuncurry beach ridge barrier shows prograded beach and nearshore deposits 6000 to 2000 yrs old overlying a thick transgressive sand unit. However, dates in the seaward-most 300m of the barrier (including a sample from the modern beach) cluster around 1700 yrs BP. Despite evidence of at least two modern incipient beach ridges the dates suggest reworking of old shell from relict deposits.

3. Broken Bay Area. Results of surface sampling, seismic reflection survey, estuarine drilling, offshore coring and power augering (on Barrenjoey isthmus) are being compiled to construct a late Quaternary geological history and sediment budget for the lower Hawkesbury River, Broken Bay, Pitt Water and the adjacent inner continental shelf. The data will include 20 radiocarbon dates on estuarine and marine lithofacies from which rates of infilling in the period post 12,000 yrs BP will be estimated. Preliminary results indicate massive tidal delta sedimentation in Broken Bay. Extensive beach-ridge progradation in the prior Brisbane Waters valley (Woy Woy beach ridges) is associated with tidal delta deposition and contrasts with minimal barrier development on the open coast. The Palm Beach barrier comprises a 5-10m thick cap of Holocene sand over a core of leached older sediments, of possible fluvial origin. Thin estuarine sediments shallowly underlie Palm Beach and suggest that this barrier is of a receded type. Layers of cemented beach-rock up to 1m thick occur within the Holocene barrier deposits over a depth range of +1 to -3m S.D.



4. Sydney Region. Quaternary data covering both coastal and inner shelf areas of the Sydney 1:100,000 map sheet have been compiled and will form part of the notes that accompany the published map sheet. The review includes a discussion of marine, aeolian and estuarine depositional environments and lithofacies followed by a description of the Quaternary stratigraphy of the Broken Bay, Sydney Harbour and Botany Bay areas based on drilling and seismic data. Sources include both published and unpublished data.

5. Sydney Offshore Study. Surface sediment, bathymetry and detailed side scan surveys have been carried out over the nearshore and inner shelf (to c. -50m) between Broken Bay and Sydney Harbour. The study will be continued south from Sydney Harbour to Kurnell in the near future. Dr Albani (Geology, University of NSW) is currently undertaking shallow marine seismic over areas of sediment delineated by the sidescan. Coring, sand tracing and hydrodynamic studies will probably be carried out by the PWD in the future.

Side scan data show extensive reef areas extending over the nearshore and inner shelf. Small deposits of nearshore sediment are confined to valley axes off embayments and are virtually surrounded by reefs. Seawards of the reefs in water depth of 40m+ are coarse, inner shelf sands and occasional patches of mid-shelf muddy sand.

6. Port Hacking. Detailed marine seismic (sparker) and estuarine coring and drilling have been carried out in Port Hacking estuary to investigate the stratigraphy and age structure of the tidal deltaic sand deposits. The drilling includes 24 undisturbed cores about 9m long and eight reverse circulation drill holes to a maximum depth of 40m. From these, 64 shell samples were selected for radiocarbon dating which is presently underway. Preliminary results from the seismic and sediment data suggests that the tidal delta sand body is 30-40m thick, 6-7km long and comprises two units: a low-shell unit with gently dipping beds in the estuary mouth and a high-shell unit with steeply dipping beds in the middle estuary. These units overlies flat-lying estuarine muds and possibly represent two phases of total deltaic deposition. Sedimentation in Port Hacking is closely associated with deposition in Bate Bay. A model describing the latter area is proposed in Roy and Crawford (1980, in press).

7. Tathra. The Tathra embayment on the South Coast of NSW is at the mouth of the Bega River which is presently supplying sand to the coast. Shoreline erosion over the past decade is connected with a major flood in 1971 that flushed large quantities of sand from the river mouth into the bay. Infilling of the over-deepened river mouth has been by sand from the beach. The sand transported offshore has not returned to the beach and does not appear to have migrated alongshore out of the sediment compartment. Despite the probability that the river has supplied sand to the coast throughout late Holocene times, there is little evidence of shoreline progradation. Samples from the narrow beach-ridge barrier of the head of the bay are being dated to determine its age. These results will test the possibility that sand supplied

by the river is transported offshore.

8. Catherine Hill Bay. A surface sediment and bathymetric survey has been carried out between Tuggerah Lake and Swansea but the data have not yet been evaluated. Side scan surveys over part of the area are planned.

9. Offshore Studies - Summary Results. Summary results of geological investigations at a number of offshore sites have been compiled in an unpublished report (GS. 1980/028). The areas include: Byron Bay, Coffs Harbour, Newcastle Bight, Bate Bay-Port Hacking and Tathra.

10. Narrabeen Lagoon. A detailed shallow marine seismic and drilling/coring investigation is planned for Narrabeen Lagoon to delineate sand resources and provide a framework for planning a comprehensive dredging and foreshores improvement program.

11. Mid-shelf Muddy Sands. A joint program with C. Phipps (Sydney University) is planned to collect piston core samples from the zone of mid-shelf muddy sand and carry out Pb 210, C14 and faunal analyses to determine age of the deposits and rates of accumulation.

#### PUBLICATIONS

Roy, P.S., B.G. Thom and L.D. Wright 1980 in press Holocene sequences on an embayed, high-energy coast - an evolutionary model. SEDIMENTARY GEOLOGY

Roy, P.S. and E.A. Crawford 1980 in press Holocene geological evolution of the southern Botany Bay-Kurnell region, central New South Wales coast. REC. GEOL. SURV. NSW 20(2)

Roy, P.S. and E.A. Crawford 1980 Quaternary geology of Newcastle Bight inner continental shelf, central New South Wales coast. REC. GEOL. SURV. NSW 19(2):145-88

Roy, P.S. 1980 Quaternary depositional environments and stratigraphy of the Fullerton Cove region, central New South Wales. REC. GEOL. SURV. NSW 19(2):189-220

Roy, P.S. and Stephens 1980 Responses of sediment and morphology to nearshore processes in southeastern Australia. Abstracts, 17th International Conference on Coastal Engineering, Sydney, March 1980, pp.74-75

#### PUBLICATIONS (in preparation)

Thom, B.G. and P.S. Roy Late Quaternary marine deposition in New South Wales and Southern Queensland - an evolutionary model.

Roy, P.S. and A.W. Stephens Quaternary geology and sediment budget for the Byron Bay region, eastern Australia. REC.



GEOL. SURV. NSW

Roy, P.S. Quaternary geology of the Sydney 1:100,000 geological map sheet. (To be included in the published geological notes to accompany this map sheet.)

Unpublished Reports

Roy, P.S. and A.W. Stephens 1980 Regional geological studies of the NSW inner continental shelf; summary results. Rep. Geol. Surv. NSW, GS 1980/028

UNIVERSITY OF NEW SOUTH WALES (Department of Geography, Duntroon)

1. The long-term efforts of the group involved in the study of the Quaternary geology and geomorphology of the Port Stephens-Myall Lakes area, NSW, is drawing to an end. The group includes Bruce Thom, Greg Bowman, Cheng Ly, Mike Shepherd and Peter Roy. All chapters have been written for a monograph to be submitted to the Department of Biogeography and Geomorphology, ANU, for publication by that department. This project has grown in scope and content over the last five years. The problem is now selecting material for exclusion given the detailed nature of the study. It is hoped to publish the monograph in 1981.

2. Dr Greg Bowman has successfully completed his PhD thesis on podzol development on Holocene sand barriers in eastern Australia. This thesis highlights the time dependent nature of soil genesis.

3. The joint project on beach-ridge dating involving the Sydney University Radiocarbon Laboratory and the Geography Department, Duntroon, is being completed in 1980. The study expands an initial work on Holocene barriers by Thom, Polach and Bowman (1978). New sites for study include Anthonys, Green and Nine Mile Beach in Tasmania, Guichen Bay in South Australia, and Seven Mile Beach (Shoalhaven area) in NSW. The project has had two main objectives: (i) to establish the age structure of beach ridges at various localities, and (2) to evaluate the problems of C14 dating materials from nearshore depositional environments.

4. During 1980 the department acquired a Mole Pioneer Universal drilling rig. This drill will be used initially to investigate the stratigraphy of sand barriers in the Gippsland Lakes region, Victoria.

PUBLICATIONS

Thom, B.G., H. Polach and G. Bowman 1978 Holocene age structure of coastal sand barriers in New South Wales, Australia. Dept of Geography, Faculty of Military Studies, Univ. of NSW, Duntroon, 86pp.