



# Australian Quaternary Newsletter

No. 5 May 1975

## UNDERGRADUATE COURSE IN QUATERNARY STUDIES

A third year option in Quaternary Studies has been introduced in the Department of Geography at Monash University. The course is broadly based and designed to improve communication between Arts and Science faculties. The departments of Botany, Zoology and Earth Science have accepted the subject as one of their options.

Through the year current evidence and controversies in the fields of vegetation history, palaeozoogeography, geomorphology, pedology and prehistory will be introduced and discussed to allow interpretation of the present-day environment and assessment of the nature of environmental stability. In addition to the more usual forms of student assessment, fieldwork and practical sessions will be largely devoted to a full research project.

Eighteen students have enrolled for the course this year; not a large class by number conscious Monash standards, but sufficient. These students are mainly the interested core from the second year physical geography unit (8 have been accepted into geography honours), supplemented by 3 fourth year Botany honours students.

The year got off to an excellent start with a field trip to Mt Buffalo. A 3 metre deep ombrogenous bog was discovered, levelled, plane tabled, vegetation and stratigraphic transects made, and a core recovered for pollen analysis in practical sessions. It is hoped that this project will contribute to the history of Australian sub-alpine areas.

Jim Peterson and Peter Kershaw, who are running the course, would be pleased to hear from Quaternary workers intending to visit Melbourne who would be prepared to contribute specialist knowledge.



## THE AUSTRALIAN ARCHAEOLOGICAL ASSOCIATION

The Australian Archaeological Association was formally established at a meeting held during the ANZAAS Congress in Perth, 1973.

Membership is open to anyone interested in furthering archaeology in Australia. The Association places no limitations on membership, and the view has been strongly expressed that people whose studies and interests impinged on archaeology should be encouraged to join.

Applications for membership and subscriptions should be sent to the Honorary Secretary, Dr Isabel McBryde, Department of Prehistory and Anthropology, School of General Studies, A.N.U., Canberra. A.C.T. Subscription is \$5 joining fee, plus \$5 per annum.

### The Role of the Australian Archaeological Association

The AAA was formed at a meeting of archaeologists in Perth during the ANZAAS meeting of August 1973. The idea of such an association had been mooted for several years, as it had in several other disciplines which also formed associations at this time. The AAA is noticeably different from the other associations in that while they are confined to "professionals", the AAA is open to anyone who has a genuine desire to further archaeology, be he employed as an archaeologist, just interested, or professionally employed in a related discipline. Exactly how the Association will function, and the details of its constitution have yet to be decided, but it seems to me that there are a number of areas in which such an association can be of considerable use to archaeologists and their associates, and I hope to see the Association active in the following spheres at least.

#### 1. Communications

A major problem facing archaeologists in Australia is isolation, and I believe that better means of communications could help relieve this. Although there are developing departments of archaeology in New South Wales and the A.C.T., in all other states, archaeologists work in departments which are not primarily oriented towards archaeology. Such people are often under pressures to deviate into other fields which may be closer to the major orientation of the employing institution, and they lack professional colleagues to turn to for advice. If the AAA can help to strengthen their positions by reminding them that there is a body of archaeologists who have the same priorities and are interested in the achievements of the individual, the association will play a valuable role. I envisage this as being achieved mainly through the newsletter.



## 2. Public Relations

We all publicise the work and achievements in archaeology in Australia, but one still meets the comment, "I don't suppose there is any archaeology in Australia!" A public awareness of archaeology is absolutely essential, for it is the general public who report sites to us, who often make considerable sacrifices to enable archaeologists to excavate, who voluntarily preserve sites which we believe are important, and in the long run, it is the general public which supports the museums and universities which employ the bulk of the archaeologists in Australia. The contribution made by individuals to the public appreciation of our aims and needs is of fundamental importance, but there are times when the individual cannot achieve as much as he would like in this field, and I believe that the AAA should attempt to supplement the individual efforts. The newsletter should be a start, but more public lectures would be desirable, and it is hoped that the AAA will be able to organise these in the future.

Each branch of archaeology will have its own particular set of priorities in public relations. For example, in the field of marine archaeology, there is urgent need for legislation to stop the looting of the nineteenth century wrecks around the Australian coast; this legislation will only come if there is sufficient public pressure and an awareness by politicians of the value of the material which is being taken from these wrecks. Prehistorians face a different situation in which Aborigines in many areas are asking why archaeologists should dig up the remains of their past; it is I think fair to say that when Aborigines fight for the recognition of such rights as land ownership, they cite the findings of the archaeologists which give a perspective to Aboriginal occupation of Australia, so that in fact there are very good reasons why Aborigines and archaeologists should work side by side for mutual advantage. But the days when the archaeologists could assume that Aborigines approved of, or at least would not object to, excavations have gone, and it is hoped that the AAA will play a role in liaison between archaeologists and Aborigines.

## 3. Archaeology and the Law

In all states in Australia, there is legislation which is intended to protect archaeological site from unnecessary damage: although there are defects in these acts, they are saving sites which would otherwise be lost, as so many have in the past. The passing of these acts was encouraged by archaeologists, and by and large, they serve the archaeologists well. There have, however, been a number of cases in which archaeologists have felt penalised or restricted by the working of these acts. It would, of course, be a perfect world if there were no misunderstandings or injustices, but it is hoped that the AAA can help to smooth the way for a better understanding between the archaeologists on the one hand and those who have the task of implementing the acts on the other. The resolution of this kind of situation would appear to lie in continuing discussions, and these the AAA can support.



#### 4. Relations with other disciplines

As indicated in the opening paragraph, the decision has already been made that the AAA will not be closed to members of other professions, and will not be a narrow "professional" society. This decision reflects the very nature of archaeology which relies so heavily on the physical sciences for its techniques, and on the humanities for its interpretation of its data. It is hoped that the newsletter can help to draw the attention of members of other disciplines to the areas in which they can liaise with archaeologists.

Ian Crawford  
President - AAA

December 1974

#### NORTHERN AUSTRALIA RESEARCH UNIT (A.N.U.)

##### Background and Purpose

The Northern third of its vast land mass has long promised all manner of tropical largess to the Australian nation, but with a few notable exceptions, the reality has been less than the promise. Since World War II there has been a considerable increase in efforts directed at seeking the reasons for the many failures and the knowledge which will increase the chances of success. Hitherto the Australian National University has played a substantial, but uncoordinated role in this part of the continent, but as the number of its members whose work led them to the North grew, it became clear that it was time the University made a distinct and concerted commitment to Northern research. Drawing upon its experience of a similar Unit in New Guinea, the University in 1973 established the North Australia Research Unit under the aegis of an Advisory Committee drawn from both the Institute of Advanced Studies and the Faculties

While the Unit's headquarters is in Darwin, its activities and research interests are expected to range over the whole of North Australia. It is not, however, the University's intention that it should compete with other agencies or individuals who are engaged in Northern research. Rather its firm intention is to cooperate with other researchers, to supplement and perhaps extend work already accomplished or in progress, and to seek out untapped areas of research which merit investigation. While the Unit has been established by the University to provide a Northern base for members of its own staff, it is hoped and expected that research



workers from other Universities, both Australian and foreign, will avail themselves of such amenities and services as it may be able to provide. The Unit also hopes to serve as a clearing house for Northern research, to which persons working in the North or contemplating doing so may turn for information.

The duties of the Unit fall into two equally important categories: Academic Activities and Service Functions.

#### Academic Activities

The Unit will, through its own academic staff, engage in research of relevance to the North. Much of this research will be of an inter-disciplinary character, although initially it is expected to fall within the general sphere of the social sciences, with special attention being paid to matters of economic and sociological importance in the development of North Australia, but the research will, of necessity, take cognizance of the historical background. Aboriginal and other minority-related problems will receive substantial attention. Eventually the research programme will be broadened to include projects in the natural and physical sciences, particularly those with a biological and ecological concern.

A publications programme is planned for the Unit, which will include a series of bulletins in which the results of research pertaining to the North will be published; an annual abstract and bibliography of Northern research under way, regardless of the agency or individual involved; and a quarterly newsletter which will report briefly and more directly on Unit affairs. It is hoped that from time to time, those who are not Unit staff who have suitable material will avail themselves of these avenues of publication.

The Unit is cooperating with others in Darwin in the establishment of a central bibliography of research resource material relating to the Northern Territory, and it will expand this bibliography to give a complete coverage of the whole of the North when this becomes possible.

As in other new organisations, most staff appointments have yet to be made. To date a field director, Field Manager and a Research Officer have been appointed and are resident in Darwin.

#### Service Functions

To most persons who come to know the Unit, even briefly, it will probably be the services it can provide which will prove most important. While few of these services will be available before mid 1975, by that time at least some of the most essential can be provided. Such will include:

- \* Reasonable accommodation for brief periods while in Darwin.
- \* Liaison with Governmental departments.



- \* Information as to road conditions, accessibility of remote areas, and general advice concerning travel in the North.
- \* A modest amount of Secretarial and/or typing assistance.
- \* Acting as agent in the purchase of some items of field equipment, in the North, thus avoiding costly freight charges.
- \* Arrangements for transport to areas served by public transport facilities.
- \* Limited use of field vehicles, depending on availability.

In time, and as rapidly as funds and staffing permit, other services will be added; these will include:

- \* Access to a library and map collection relating to North Australia.
- \* An up-to-date bibliography of research recently undertaken and under way in the North.
- \* Access to a bibliography of research resources material relating to North Australia.
- \* Telex communication with the rest of Australia.
- \* Storage facilities for gear and equipment to be left in the North.

#### Directory of Research in Northern Australia

The North Australia Research Unit is concerned with northern research in its broadest sense. In the brief period the Unit has been in existence one aspect of research in North Australia has become apparent: while a substantial body of research is under way in this vast and varied region, its full scope, nature, location and the individuals involved are very sketchily known. The Unit believes that were those working or interested in work being undertaken in the North fully aware of what is being done in their own and in other fields and the opportunities which exist, research would be stimulated to the advantage of the country as a whole. Therefore one of the tasks the Unit wishes to assume is the compilation and publication of an annual directory of research in progress in North Australia as a whole.

The directory will contain brief resumes of research organised under major subject headings and will include the names of the individuals engaged, the location of the projects, the agencies sponsoring it and note of recent publications which have resulted. It is hoped to include as broad a range of disciplines and sponsors as possible, and in this connection recipients of this request are



asked to give it wide dissemination. Contributions will be entirely voluntary and will not be edited. Since the entries will report upon research in progress it will be clearly understood and stated that further publication of its contents without the written permission of the contributor will not be sanctioned. Bibliography of published work relating to the North will be included. Publication will be by standard offset methods under the NARU imprimatur. In order to permit prompt handling of the entries, contributors are asked to observe the following suggestions:

1. No major editorial control will be exercised, but contributors are requested to report only upon *bona fide* research projects which have or are expected to result in publication in books, monographs or reputable journals.
2. Entries in the directory will be organised according to discipline and type of research, and to ensure that they are properly classified, contributors are asked to indicate the *major* subject heading under which their work falls (e.g. Agriculture) and one or more subheadings which would help to classify it more precisely (e.g. pasture improvement). Specific locations in which research is being prosecuted or the area to which it applies is also requested.
3. Contributors are requested to report *all* projects under way, but each resume should be typed on a separate sheet.
4. Wherever possible resumes should be kept to 2-300 words.
5. While the Unit wishes to make no firm delineation of its geographical sphere of interest, for the purposes of this publication it wishes to consider North Australia as those parts of Western Australia north of the Tropic, all of the Northern Territory and Queensland west of a line connecting Birdsville and Townsville. Contributions covering research being prosecuted anywhere in this broad region or having application, direct or potential, to it are requested.
6. Contributions should be sent to the Unit's Darwin office where they will be collated and assembled.

Further enquiries should be directed to Dr F.H. Bauer, Field Director, N.A.R.U., P.O. Box 3121, Darwin, N.T. 5794.



## BOOK NOTICES

W.W. Bishop and J.A. Miller (editors) 1972. *Calibration of Hominoid Evolution - Recent advances in isotopic and other dating methods applicable to the origin of man.* Scottish Academic Press, Edinburgh, 487 p.

Although this volume appeared in 1972, it may be of interest to many to make a brief report on its contents in this Newsletter. It is the proceedings of a symposium held at Burg Wartenstein, Austria in 1971. The conference was originally conceived as a confrontation between *daters* and *consumers*. The editors claim that no confrontation as such took place at the meeting.

The volume provides readers with many useful papers which summarize the "state of the art" on such techniques as radiocarbon dating, uranium series dating, methods of calibration of deep-sea cores, application of potassium argon methods to Pliocene and Pleistocene strata, use of geomagnetic reversals, fission track dating, and methods of dating fossil bones. Unfortunately, there is no treatment of thermoluminescence techniques. The second half of the volume contains papers on the application of radiometric dating to various cases of hominoid evolution/ Africa receives particular attention. With the exception of one reference to Mulvaney (1966), Australia does not seem to be very relevant.

The contributors to the volume are all specialists in their fields/ I found papers by Thurber, Broecker and Bender, Bandy, Miller, Fitch, Cox, and Dalrymple of particular interest, but I am not an archaeologist. These papers outline quite succinctly the various pitfalls of "dating" techniques.

All potential users should be familiar with the problems discussed here. The volume could be of great assistance to research students about to embark on a dating programme, whether it be in a geological or a prehistorical context.

B.G. Thom

G - J. Bartstra and W.A. Casparie (editors) 1975. *Modern Quaternary Research in Southeast Asia.* A.A. Balkema, Rotterdam, 114 pp A\$6.50, Dfl. 18.

This book reports the papers read at a symposium on modern Quaternary research in Indonesia which was held at Groningen in May 1974. The major contributions are a review of palaeoclimatic evidence and land-form development by H. Th. Verstappen and summaries of aspects of the prehistories of Malaysia-Indonesia. Verstappen considers the theoretical effects that postulated past climates and sea levels would have had on the region, using modern climatic data from the



region, the Pleistocene glaciation data from New Guinea and Borneo, and Sunda Shelf sea levels, as his main local data sources. He goes on to discuss coastal changes during low sealevel and rising sealevel stages. He concludes that temperatures were between 5 - 9°C colder than present and conditions were drier due to lower precipitation values and a longer dry season. The low gradient of the shelves did not permit rivers to incise deeply during low sea levels, but a blanket of clay marks times of high sea level during interglacial and Holocene humid times.

T. Harrison provides new dating and geological information about the palaeolithic of Malaysia, and concludes that dating of sequences and their nature are still confused, although a tentative chronological development is put forward. This can be compared with a table of Indonesian Prehistory prepared by the late H.R. van Heekeren. D.A. Hooijer reviews the current knowledge of the large mammals, in particular the stegodonts and elephants known as far east as Timor. Evidently the early Pleistocene is much better known in Indonesia than Australia although work covering the last 40,000 years may be less intense. The book concludes with a section on the characteristics of the widespread coastal and deltaic peats. Some dated occurrences seem to be only a few thousand years old, and related to the modern sealevel.

The book is recommended as a useful contribution in several Quaternary fields, of especial value for the access provided to Dutch or unpublished data. It was obtained for only A\$5.35 by the reviewer by sending the Dutch florin price direct to the publisher (P.O. Box 1675, Lissplein 11, Rotterdam); this could vary with the exchange rate of course.

G.S. Hope

*Proceedings of the Second International Symposium on Coral Reefs*, Great Barrier Reef Committee, Brisbane, 2 vols., 1974.

These two volumes are the product of the magnificent symposium held on board the M.V. Marco Polo cruising the waters of the Great Barrier Reef in July, 1973. It was my privilege to attend this symposium. There are 114 papers in the two volumes ranging widely in subject matter. Volume 1 is primarily concerned with biological problems (e.g. productivity studies, biogeography of reef communities, *Acanthaster* problems). Volume 2 covers various regional studies, carbonate sedimentation and diagenesis, geological evolution of reefs, and problems of conservation. Of particular interest to Australian Quaternarists are studies on sealevel change (e.g. Honley) reef



## RESEARCH REPORTS

## QUEENSLAND

Helen Brayshaw, Department of History, James Cook University, Townsville is working on an archaeological survey of the Herbert/Burdekin district in North Queensland. As part of the field survey, four small excavations were undertaken during 1974. These were at the foot of the range to the west of Kennedy; near Jourama, about 15 km south-west of Ingham; at the base of Herveys Range, 25 km west of Townsville; and near Mt Roundback approximately 20 km north of Bowen.

Shell material, not yet analysed, was obtained from all sites, and bone was also found in all sites, although markedly less at Mount Roundback. Analysis of the material is in progress. Preliminary examination of the stone artefacts and waste material shows a predominance of quartz, particularly at Mt Roundback, where the deposit consisted almost entirely of quartz, with only a few definite signs of utilization. The three sites to the north all produced a greater amount and more varied utilized material than Mt Roundback, particularly Hervey's Bay and Jourama. In no case does the typical typology seem to apply; utilized pieces are quite irregular and there is very little evidence of secondary retouch. Dates so far obtained from these sites are all less than 1650 BP.

A.C.T.

G. Singh, Department of Biogeography & Geomorphology, Australian National University. Pollen-analytical studies on a 9 m core, dating from well beyond radiocarbon dating limit, from Lake George, New South Wales, have established the occurrence of five wooded periods, zones J, H, F, D and A, alternating with an equivalent number of non-wooded horizons, zones K, I, G, E and C. Zone B being transitional between zones A and C. The wooded periods, excepting zone A at the top of the sequence, represent cool temperate forests and correspond to high, freshwater phases in the lake basin in contrast to non-wooded herbfield - grasslands which co-exist with phases of low, brackish water to dry lake conditions. Zone A, representing most of the post-glacial period, marks the first development of warm temperate dry sclerophyll woodlands in the section and runs contemporaneously with a low brackish water to dry oscillatory phase. From the evidence presented it is argued that the low-lake-level, non-wooded periods were representative of cold dry conditions while the cool wet temperature forests were established during temperate or mildly higher temperatures than before. In view of the fact that higher temperatures would have led to higher rates of evaporation as well, it is inferred that there must have been a corresponding rise in precipitation during each of the cool temperate periods. The general fall in the lake levels during the post-glacial period is interpreted as a response to higher rates of evaporation brought about by higher temperatures than had occurred at any time in the previous time period covered by the section. Rainfall increases, if they occurred during the Holocene were not sufficient to compensate for the present climatic regime.



## NEW SOUTH WALES

G.T. Walker, Department of Geography, University of New England, has just begun working on the surface morphology of the Gwydir Riverine Plain and hopes to make some real progress (after a lot of teaching commitments) during the middle of 1975. At the outset there appear to be many parallels with the Murrumbidgee Riverine Plain but many interesting contrasts also.

## NEW GUINEA

Ernst Löffler, C.S.I.R.O. Land Research, has been investigating Pre-Wurm glaciation (s) on Mt Giluwe, in Papua New Guinea. On Mt Giluwe a history of repeated glaciation interrupted or followed by extrusions of lava (partly subglacial) has been suggested.

During recent field investigations, lava flows overlying or associated with older moraine material or palagonitic breccia have been collected and submitted for K-Ar dating. Unfortunately only 5 of the 10 samples proved suitable for dating, which is in progress. The dates are hoped to provide the answer to whether there was only one pre-Wurm glaciation or at least two.

## SOUTH AUSTRALIA

Discipline of Marine Geology and Geophysics, Flinders University.

Chris von der Borch, David Lock, Robert Plush:-

Detailed stratigraphic, mineralogic and hydrologic studies are continuing in the Coorong area, South Australia, in order to document the environment and modes of formation of the variety of carbonate minerals which include dolomite, magnesite, hydromagnesite, calcite, Mg-calcite and aragonite. A series of piezometers have been placed in selected carbonate lakes and into the adjacent groundwater table and levels will be monitored through a seasonal cycle in order to de-lineate the relative role of groundwater vs. seawater chemistry in different areas in producing the resulting variety of carbonate minerals. This work is being combined with a detailed coring programme of all the sedimentary environments. From this, carbonate mineral variations and microstratigraphic patterns are being determined. The result of this programme will be to document the typical Holocene sedimentary cycle in the area and to throw light on dolomite genesis. The emerging pattern in a typical core is a vertical sequence, from a basal transgressive sand over Pleistocene calccrete upwards through a lagoonal skeletal packstone (aragonite and Mg calcite) to dolomite or dolomite-magnesite mud. This succession is basically regressive in nature and reflects the progressive restriction of the area from the marine and lagoonal environment and the increasing role of groundwater.



An aspect of the study which will receive special attention is the occurrence of significant phosphate in some of the Holocene lagoon sediments. Dave Lock detected a Calcium phosphate mineral at depth in a core during routine X.R.D. and chemical analyses.

Chris von der Borch:-

C<sup>14</sup> ages on molluscs and carbonate sediments from lakes near the Coorong lagoon are being determined by Henry Polach (A.N.U.) in conjunction with the above study. The work is in the initial stages, but well-controlled evidence for a +1m high stand of the sea is indicated for the area, between about 6,000 and 6,600 years B.P.

Scanning electron microscope studies of typical modern dolomite muds from the Coorong area are being carried out in conjunction with Dr J.B. Jones (Geology Dept., University of Adelaide). The modern dolomites, which are moderately well ordered, appear to have a spherule-aggregate ultrastructure, with spherules measuring about 1µm dia. Diagenesis causes the spherules to recrystallise, first into spherical aggregates of minute rhombs and then into individual rhombs. The above structures suggest a gel-like precursor to dolomite of pre-existing aragonite for most cases.

In conjunction with regional studies of the southeastern coastal plain of South Australia, sources of Mg ions for the extensive dolomite formation in the area are being sought. A possibility under study includes breakdown of unstable Mg-calcite allochems in the Tertiary and Pleistocene carbonate aquifers. Another possible source may be volcanic ash in Western Victoria and the Mt Gambier - Mt Burr region, both areas of which are situated near source areas of much of the underground water that forms the dolomite. If some of the Mg can be shown to come from the volcanic ash then the study will be enlarged to encompass possible base-metal enrichment in reduced Pleistocene lagoon sediments associated with dolomites beneath the coastal plain. Leaching of the basic volcanics could supply the necessary primary metal concentrations for such an enrichment.

Doug Schwebel:-

The Pleistocene stratigraphy of the seaward half of the coastal plain of southeastern South Australia is being studied by Doug Schwebel for a Ph.D. thesis. Stratigraphic drilling of interdune flats has begun in the area near Robe and a working model proposed which relates the pattern of stranded barriers to the known sealevel fluctuations of the last 120,000 years. This model will be upgraded as drilling continues and it is hoped that meaningful U/Th ages will be obtained from some of the Pleistocene lagoonal aragonite muds.

Chris Waters:-

Grainsize, sorting and CaCO<sub>3</sub> content, have been determined for about 500 surface sediment samples from St Vincents Gulf. Resulting sedimentary patterns are being appraised in terms of numerical models of water circulation and sediment transport. This study is essentially complete, and will be incorporated in a Ph.D. thesis early in 1975.



Herbert Veeh:-

Current research activities relevant to Quaternary Geology:

- I. Uranium series (Th-230/U-234) age determinations of emerged coral reef terraces in island arcs,
  - (A) Portuguese Timor (jointly with J. Chappell, ANU, and in association with the Flinders University Banda Arc Project).
  - (B) New Hebrides Is. (jointly with G. Neef, University of Wellington, New Zealand).

The aims of this study are (1) to quantitatively assess the rate of vertical tectonic movements of the earth's crust along lithosphere plate boundaries and (2) to supplement and further define the absolute chronology of Quaternary glacio-eustatic sea level fluctuations as defined on Huon Peninsula, New Guinea (see J. Chappell, Newsletter No. 4, Oct. 1974).

II. Uranium-series age determinations of inorganically precipitated lagoonal carbonate sediments. This study, as part of the Ph.D. program by Doug Schwebel, is an attempt to extend the uranium series method to material other than corals. The coastal area of south-eastern South Australia is particularly well suited for a study of this kind. The Coorong, with its semi-restricted lagoon and associated ephemeral lakes provides an ideal opportunity to observe the processes involved in the precipitation of various carbonate minerals. A detailed isotopic analysis of recently formed carbonate sediments, coupled with analyses of recently formed carbonate sediments, along with analyses of the overlying water, is currently being carried out to aid in the selection of the most suitable material for dating. The validity of uranium-series age determinations as applied to selected carbonate facies can be checked by analyzing a series of older lagoonal sediments related to previous high sea stands during the Pleistocene. Since the stratigraphic relationships of these deposits can be established by fieldwork, no ambiguity should exist as to their relative ages. Final verification of the radiometric ages will depend on satisfactory agreement with generally accepted Pleistocene chronologies in other areas.

Rod Wells, School of Biological Sciences, Flinders University

Vertebrate palaeontology in South Australia has just received a boost with a Federal Government Grant of \$80,000 for a laboratory and on site museum at the Victoria Cave dig in the south east of the State. The initial grant is for the buildings with another \$80,000 to be allocated in the next financial year for the museum displays and the upgrading of the cave walkways and lighting.

The displays will feature reconstructions of giant Late Quaternary marsupials as well as birds, reptiles and amphibians. Apart from its obvious tourist interest it is envisaged that the site will play an important role in the teaching of Matriculation Biology.



Rod Wells has also recently received an A.R.G.C. grant for the Victoria Cave work and has been able to employ Barbara Nichol as a technician to help in the preparation of the fossils. Barbara has just completed the preparation of the manus and pes of *Thylacoleo* and Rod has temporarily put to one side the larger Victoria Cave paper to get this one into press. Having been converted to screen washing by Dick Tedford, Tom Rich et al., we have been processing the spoil from the dig. Mike Tylor has been sorting through the bone collected in this fashion and had identified 125 frog specimens. While Mike is describing the frog material, Meredith Smith has been busy with the reptiles and has a paper ready for submission.

Dianne Warren has joined us as a Ph.D. student at Flinders University and is working on the biomechanics of locomotion in the kangaroo, she hopes to extend her model to a functional analysis of the fossil forms.

#### FIELDWORK ASSISTANCE WANTED

Dr J.F. O'Connell will be continuing his archaeological and ethnographic studies on MacDonal Downs Station, some 200 km NE of Alice Springs, through a field season extending from 20 May to 10th September 1975. The coming season will be archaeological, involving detailed mapping of surface features, and systematic collection of occupation material at a large, recently occupied, Aboriginal habitation site.

Four or five volunteers are required, preference being given to those who can work for all or a major part of the season. Return air transport to Alice Springs from any point in Australia and all subsistence will be provided. However, volunteers must camp out and must provide their own personal gear and bedding. If interested, please contact, as soon as possible,

Dr J.F. O'Connell,  
Department of Prehistory,  
Research School of Pacific Studies,  
Australian National University,  
P.O. Box 4,  
CANBERRA. A.C.T. Phone (062) 493276

In the Carnarvon Range, Central Queensland, Mr J.M. Beaton will be excavating a number of rock-shelters to determine differences in economic use of sites within a complicated environment. A work force of about six volunteers is required for the field season which extends from 1st July to 1st October, 1975. Persons may



participate for any part of the project, the absolute minimum period being ten days. Full subsistence will be provided and some contribution towards fares may be possible, particularly for those intending a lengthy stay. However, volunteers will camp out and must provide their own bedding and other personal gear.  
Contact

Mr J.M. Beaton,  
Department of Prehistory,  
Research School of Pacific Studies,  
Australian National University,  
P.O. Box 4,  
CANBERRA. A.C.T. Phone (062) 495017

#### QUATERNARY SHORELINES

##### Project on "Sea Level Movements During the Last 15,000 Years"

Arthur Bloom (Department of Earth Sciences, Cornell University)  
reports on the development of the project:

At its meeting in Vienna in April, 1974, the IGCP Board accepted the project "Sea Level Movements During the Last 15,000 Years". This project was first proposed by Dr A.A. Thiadens, Director, Geological Survey of the Netherlands, following the earliest discussion of IGCP (International Geological Correlation Programme) in 1970, and has received favorable consideration at each subsequent stage of development. Now, as IGCP has become organized under IUGS and UNESCO, the project is about to begin.

At an early stage (in 1971) INQUA was asked to sponsor the sea level project, and the President of INQUA at that time, Professor G.F. Mitchell, asked Dr A.L. Bloom of Cornell University to develop the project. A preliminary working group was formed, with Dr A.L. Bloom as leader and Dr B.P. Hageman of the Geological Survey of the Netherlands and Professor H.G. Richards of the Philadelphia (U.S.A.) Academy of Natural Sciences as members. The latter are respectively the Presidents of the INQUA Commission on the Holocene, and the Quaternary Shoreline Commission. To insure the coordination of the IGCP sea level project with the work of these important INQUA commissions and their various subcommissions, Dr Bloom was elected to membership of both commissions during the 1973 INQUA Meeting in Christchurch, New Zealand.

The primary objective of the project is to establish a definitive graph of the trend of mean sea level during the last deglaciation and continuing to the present time. This graph must be an expression of the changing hydrologic balance between ice and water in response to climatic change. Individual records of relative sea level movements from all over the world will be used to compile the sea level graph. In turn, the differences among the local records will be used to draw conclusions about local crustal movements along coasts, and about fundamental parameters of strength and elasticity



of the earth's outer layers. Future trends of sea level movements will be predicted. The headquarters of the project is in the Department of Geological Sciences, 211 Kimball Hall, Cornell University, Ithaca, New York, 14850, U.S.A.

The project has been planned to continue for 7 or 8 years. To draft a working scheme for the project during the coming years, the IGCP Board held a planning meeting of a very small group of specialists, in Haarlem, Netherlands, on September 26-27, 1974. It is hoped to hold future meetings in "developing nations", especially where coastal research is of considerable relevance to land use practices.

1973-74 Research on Quaternary Shorelines in Australia and New Zealand  
a summary report of the ANZAAS Quaternary Shorelines Committee

Introduction

Controversial issues which have dominated Quaternary shorelines literature over the last ten years appear to be largely resolved in the light of recent publications. Two questions in particular appear to be well on the way towards being answered and major contributions have been made from Australasia in both issues. The question of a late Pleistocene interstadial high sea level appears to be largely a problem of dating techniques. A major review of this question is that of Thom (1973). The question of Holocene sea level curves may also be explainable in the light of increasing information on hydro isostasy (Walcott 1972; Chappell, 1974). Water loading and variations in crustal response appear to go a long way towards explaining the differences in evidence for Holocene shorelines on different coasts.

Further details of late Pleistocene sea levels are appearing again with notable contributions from the Australasian region. Future lines of research may try to increase this detail and document the regional differences in evidence for dated shorelines. A major task is to reconstruct the sea level history of earlier parts of the Quaternary. In all these fields Australia, New Zealand and New Guinea are in a position to make a major contribution.

David Hopley  
Honorary Secretary

NEW SOUTH WALES

Part 1 Review of Published Material

1. Albani, A.D. and Johnson, B.D. (1974). The Bedrock topography and origin of Broken Bay, N.S.W. *J. Geol.Soc.Aust.* 21, 209-214.

A seismic survey of Broken Bay, using a sparker system, shows a channel cut 76 m into bedrock below the Palm Beach tombolo, which was therefore the original outlet channel for Pitt Water. At the entrance of Broken Bay, two major bedrock channels, corresponding to the Hawkesbury River and Brisbane Water, join at a depth of 125 m below sea level.



2. Langford-Smith, T. (1973). Evidence for a late Pleistocene interstadial on the North Coast of New South Wales. *Abstracts 9th Congr. INQUA*, 200-201.

The inner barrier system of Northern New South Wales and Southern Queensland, which gives virtually no evidence of tectonic deformation, relates to a sea level some 2 to 3 metres higher than that of today. A number of  $C^{14}$  dates of the cellulose fraction of driftwood have given late Pleistocene dates ca. 35,000-45,000 BP. However, 3 background counts (2 of them since the above paper was presented) suggest sample contamination, and suggest an interglacial rather than an interstadial age for the inner barrier.

3. Shepherd, M.J. (1974). Progradation of a Holocene sand barrier in N.S.W. *Search*, 5, 210-211.

Radiocarbon dates from an outer barrier indicate rapid progradation at the end of the Holocene transgression, followed by 4,000-5,000 years during which the sand budget has been closely balanced. During this time the coastline has been relatively stable apart from local phases of progradation and retrogradation which have occurred in response to varying wave conditions and fluctuating supplies of sediment.

4. Thom, B.G. (1973). The Dilemma of high sea levels during the last glaciation. *Progress in Geography*, 5, 170-246.

Over 160 published papers together with appreciable unpublished material relating to possible late Pleistocene interstadials have been reviewed. There is considerable conflict in this material. However, while it seems certain that minor and/or localized warm conditions prevailed, there is no convincing evidence of a warm interval comparable in intensity or duration with that which exists today, or those that occurred during the last interglacial.

5. Thom, B.G., McLean, R.F., Langford-Smith, T. and Eliot, I. (1973). Seasonal beach change, Central and South Coast, N.S.W. *Inst. Eng. Aust., National Conference Publication*, 73/1, 35.

The traditional view has been that New South Wales beaches are prograded during mild conditions in summer, and cut by high energy waves in winter. However, a number of recent studies have indicated that there is no regular seasonal beach response to wave conditions, but that cut and fill may occur at any time of the year.

6. Thom, B.G. (1974). Coastal erosion in Eastern Australia. *Search*, 5, 198-209.

Abundant nearshore sand supplies and a relatively stable Holocene sea level on the Eastern Australian coast combined to produce an accreting coast over the period 6,000-4,000 BP. As the quantity of sand waned ca. 4,000 BP, the tendency for coastal erosion became more apparent. During this period, unusual combination of events, such as a series of tropical cyclones following closely on each other, were responsible for causing very marked recession over short periods such as a few months.



## Part 2 Notes on ongoing research

Since the 1973 INQUA Congress when T. Langford-Smith (University of Sydney) discussed evidence from the North Coast of New South Wales for a late Pleistocene interstadial, Mr H. Polach (Australian National University) has run a new series of  $C^{14}$  cellulose assays from inner barrier driftwood in the Evans Head region. Although most samples have continued to give late Pleistocene ages, two have given background counts. There is thus a small but growing number of background results, strengthening claims that most former dates must have been contaminated, and that the inner barrier is probably an interglacial formation.

Dr B.G. Thom and Dr J. Chappell (Australian National University) have been working jointly on a project aimed at bracketing possible sea level changes in Southeastern Australia within the last 10,000 years. Dr Chappell has been examining methods for calculating hydro-isostatic movement of the ocean shore and continental shelves in relation to eustatic change in sea level. In another continuing project, Dr Thom is running a series of transects across the New South Wales inner and outer barrier systems with a drilling rig. He is concerned with evidence relating to both the mode and time of formation of the barrier systems.

Dr M.J. Shepherd (Massey University, New Zealand) has published a study on progradation of a Holocene barrier in Northern New South Wales. His findings indicate that the New South Wales outer barrier formed very rapidly at the close of the Holocene transgression, and that during the last 4,000-5,000 years the sand budget has been closely balanced apart from local cut and fill in response to varying wave conditions and fluctuating supplies of sediment.

Dr B.G. Thom has published a paper supporting the conclusions of Shepherd above. His review of a number of recent research projects demonstrates that unusual combinations of events, such as tropical and extra-tropical cyclones closely following one another, can cause very marked recession in a period of a few months.

Work on short-term shoreline change is being carried out by B. Caton (University of New England) at Brunswick Heads, New South Wales. Mr Caton is correlating such short-term changes with variables such as wave regime, and storm surges associated with tropical cyclones. A closely related project is that of Mr E.A. Bryant (Macquarie University) who is studying beach fabrics and their response to wave processes, while Mr R.W. Kidd (Macquarie University) is studying sedimentary budgets of N.S.W. coastal inlets with respect to variables such as river discharges. Professor J.L. Davies (Macquarie University) is examining shore platforms in environments which differ with respect to lithology, wave energy and other variables.

Mr G. Bowman (University of Sydney) is continuing with a project concerned with diagenesis in sand barrier systems. With the aid of electron microscopy, he is examining the effect of podzolisation on the surface of sand grains.



## NEW ZEALAND

Sea-level changes in the last 15,000 years

Some coastal features of the Wellington region have been raised and tilted as a result of tectonic uplift in A.D. 1855 and c. A.D. 1460, but higher and older beaches of Holocene age could be partly due to eustatic stillstands above the present level (7). Evidence from a number of places in the Northland and Auckland regions (6) confirm, for those regions, that there has either been a eustatic high of +2.1 m (3,900 radiocarbon years BP) or that there has been epeirogenic uplift over a distance of at least 270 km. Since the +2.1 m sea level there have been a number of sea-level fluctuations.

Coastal processes

Information about nearshore sediments and marine currents can be essential for full understanding of the coast. Thus the descriptions of sea-floor sediments within the Bay of Plenty (2); the Hawkes Bay region, where there are sedimentation rates of up to 0.36 m/1,000 years (4, 5); and off east Otago (1), are important, as are the current measurements at various depths around the South Island and SE of the North Island (1, 3).

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6. Schofield, J.C. (1973). *Ibid*, 359-366.
7. Stevens, G.R. (1973). *Ibid*, 455-484.

J.C. Schofield

## NORTHERN TERRITORY

There is a growing body of research (e.g. by Jennings, Thom, Wright) into coastlines in northern Australia, but very little in Northern Territory as such. During July, 1974, M.A.J. Williams and M.F. Clarke completed a survey of the chenier plain immediately south of Point Stuart. The cheniers, sampled by Williams and R. Wasson in August 1971, have  $C^{14}$  ages of 4,500 and younger, are up to 1.5 m deep, and have bases which are no higher than the present spring high-tide level.



Progradation during the past 4,500 years has been at a rate of roughly 15 to 30 cm/year. Results will be submitted for publications shortly.

M.A.J. Williams

## QUEENSLAND

### Ongoing research

In the University of Queensland, Department of Geology and Mineralogy, a number of relevant research programmes are being undertaken.

Peter Flood is studying the sediments and sedimentary processes in specific reef types of the Great Barrier Reef Province. Areas of investigation include reefs of the Capricorn-Bunker Groups east of Gladstone and reefs of the Howick Group north of Cooktown.

Michael Friederich has commenced an M.Sc. investigation of the so-called "raised" coral reefs of Peel Island and the Cleveland area and is evaluating evidence from the foreshores of Moreton Bay. Subsurface investigations are being made in mangrove swamps and salt marshes in the Cleveland area.

A.T. Grenfell; a B.Sc. (Hons.) study on sediments and sedimentation in the carbonate-terrigenous province of a nearshore insular fringing reef around Double Island, Cairns.

Lance Grimstone has developed an expert eye for the various profiles shown on modern beaches. He is working on the Gold Coast, in association with the City Council, studying coastal processes and sand transport beneath shoaling waves. The formation of inner and outer barriers of the Coolangatta area is being related to these processes, and the effects of Quaternary environmental changes is being assessed.

John Hughes has commenced (for M.Sc.) a study of the geomorphic history of the Brisbane River valley, with emphasis on Pleistocene effects. Physiographic features such as knick points, gradient changes, and perched gravels are being examined, and evidence for former high base levels is being sought. The Department of Harbours and Marine has provided him with geophysical records for the lower Brisbane river. There is evidence that the Brisbane river is incised in an older fluvial and marine sequence deposited during an early phase of marine transgression.

John Jell is continuing his work on reefs. He has a special interest in the microstructure, growth, and distribution of scleractinian corals.



Norman McIntyre had commenced a M.Sc. study of sedimentary processes in the southern part of Great Sandy Strait and is giving some attention to modern sedimentation in adjacent environments.

Andrew Stephens; Sediment transport in coastal inlets and related environments in the Moreton region. The hydrodynamics of coastal inlets are being related to channel and bank dynamics, sedimentary structures and textures in an effort to develop criteria for the recognition of ancient sedimentary environments and depositional systems.

In other Queensland university departments:

Chris Bell (Botany) is continuing his work on the Quaternary and modern palynology of Coalstown crater, in the South Burnett district.

Ed Lovell (Zoology) is trying to unravel the history of coral development in Moreton Bay. His main study sites are Flinders Reef, Peel Island, St. Helena and Green Island. The nature of past marine environments is being determined from a study of beach ridges and associated elevated (2 m) beach rock on St. Helena Island. He reports that almost all of the coral that was living in the western part of the bay was wiped out by the Australia Day flood. He attributes this to the drop in salinity produced by the floodwater.

The C.S.I.R.O. Division of Soils (W.T. Ward and C.H. Thompson) are investigating soil distribution, stratigraphy and chronology of the coastal sands of southern Queensland.

A general soils reconnaissance of the S.E. Queensland coastal sands has been completed and field work connected with the definition of depositional units is well advanced. Ten major episodes of sand dune formation are recognised. Relations with stranded beach deposits permit subdivision of the dunes into early Pleistocene, late Pleistocene and Holocene. Two Pleistocene shorelines are known. The oldest, at an elevation of 3 m pre-dates most of the coastal sands. Clear geomorphic and stratigraphic evidence supports recognition of another later shoreline, at +1 m, that is cut into the well-known "coloured sands". Both shores are associated with sandrock. The older one beneath the "coloured sands", is like the younger one but there are some differences that enable the two to be separated.

Each episode of sand-blowing responsible for the dune deposits occurred at a time of low sea level. One episode of blowing seems to be associated with a low Holocene stand of the sea.

In spite of apparently great age, and strong leaching, significant differences in productivity still differentiate the sand dune formations.

In North Queensland research centred in the Department of Geography, James Cook University, is providing further confirmation of the variability of evidence for Holocene sea levels along the Queensland



coast. New 14C dates obtained include:

- GaK-5215 Coral from Middle Island *in situ* from beneath a 1 m raised reef beneath raised beach rock deposits -  $5120 \pm 115$  years BP. This correlates with a date of  $5290 \pm 120$  years BP (GaK-4894) obtained for a *Tridacna* also *in situ* from the same level.
- GaK-5216 Coral from a 2.3 m raised beach rock terrace on Holbourne Island  $3350 \pm 95$  years BP. An older adjacent terrace rises to 3.7 m and an even older terrace is at 2.7 m and has produced 14C dates of between 5970 and 6020 years BP.
- GaK-5217 Coral from the modern reef flat of Holbourne Island  $60 \pm 70$  years BP. This was suggested in the literature as a raised reef but the date confirms that it is part of a reef killed by reduction in moated water levels by the 1918 cyclone which caused modification to the islands shingle ramparts.

Miss A.A. Smith has completed a Masters thesis on fringing reef sediments and with Dr D. Hopley and Dr R.F. McLean (A.N.U.) is examining cores from the Hayman Island fringing reef. Two dates obtained to date are -

GX 3577 Coral from c. 63 feet  $\geq 39,000$  years BP

GX 3576 Coral from c. 49 feet  $8245 \pm 285$  years BP

A further 10 dates are being obtained from these cores which should provide both a sea level curve for the island, and also an indication of the way the fringing reef has developed. Geochemical analysis of the core materials is being undertaken.

Professor A.L. Bloom (Cornell University) whilst visiting James Cook University cored the mangrove swamps of Hinchinbrook Island. Two relevant dates have been obtained:

GaK-4895 From 5 feet beneath surface -  $4680 \pm 135$  years BP

GaK-4898 From 20 feet beneath surface -  $7130 \pm 150$  years BP

Mr A.P. Spenceley investigating sedimentation rates in mangrove swamps (Ph.D.thesis) is extending this work of Bloom.

Results are now being obtained from the Royal Society - Universities of Queensland expedition to the Great Barrier Reef. They suggest a marginally higher sea level (1 m) of mid-Holocene age on the reef islands between Cooktown and Cape Melville.

D. Hopley



## SOUTH AUSTRALIA

A co-operative programme involving the Bureau of Mineral Resources (Dr P. Cook), the S.A. Department of Mines, (Messrs J.M. Lindsay and J.B. Firman) and Flinders University, (Prof. C.C. Von der Borch and Dr H.H. Veeh) is at present in progress in the South East of South Australia. The programme involves drilling continuously cored holes through Quaternary dunes and interdune deposits between Naracoorte and Robe. The main aim of the project is to establish a sea level curve for the area, and to date material recovered during drilling if this proves to be possible.

The sequences intersected are being correlated with the regional stratigraphy established for this area. Palaeontological work is being carried out to establish faunal changes across the Tertiary-Quaternary contact and to locate the *Victoriella* (foraminiferal) zone near the top of the Gambier limestone so as to determine the amount of faulting and warping.

D.B. Pappageorgiou completed a study on the cliffed coastline near Ardrossan as part of an Honours degree in Geography at Flinders University. A series of models of cliff retreat in the area were suggested, while a full photographic record of these cliffs makes possible a future analysis of rates of change of cliff form over time.

R.P. Bourman

## TASMANIA

Four undergraduate theses relating to Quaternary shorelines have been completed recently at the University of Tasmania.

Hurburgh, Wendy Maree, (1973). The geomorphology of Dodges Ferry district, southeastern Tasmania. Unpublished Hons. Thesis, University of Tasmania.

Mills, Christopher Hubert, (1973). The geomorphology of the Sandford district, southeastern Tasmania. Unpublished Hons. Thesis, University of Tasmania.

Shield, Michael Bowen, (1973). The geomorphology of the southern part of the South Arm Peninsula, Tasmania. Unpublished Hons. Thesis, University of Tasmania.

Sloane, Derek John, (1974). The geomorphology of the George Bay area, St. Hellens, Tasmania. Unpublished Hons. Thesis, University of Tasmania.

N.K. Chick



## VICTORIA

Part 1 Published work

Ward (1973) correlated higher sea-level changes in Gippsland, Victoria, and on Oahu Island, Hawaii. Stearns (1974) disagreed with certain of Ward's correlations, to which Ward provided a reply (p. 1190).

Gill (1973a) applied recent hypotheses to changes of sea-level in Bass Strait. A second list of radiocarbon samples from Victoria (Gill 1973b) includes some from emerged marine beds. Gill and Gill (1973) describe the geology of Port Fairy, Western Victoria, which includes a Penultimate Glacial valley extending 30 m below sea-level at the coast (K/Ar on basalt 300,000 yr.), a Last Interglacial +7.5 m level (U/Th on shell 125,000 yr.), and Postglacial levels dated by  $C^{14}$ . Gill (1973c) described the very different rates and modes of coastal retrogradation for four lithologies on the coast of Western Victoria. Gill (1974) pointed out that if oxygen isotope and/or palaeontologic evidence is available to prove higher temperatures, then even a rough U/Th date allows the higher sea-level concerned to be identified.

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 Gill, E.D. (1973c). *Boreas*. 2, 143.  
 Gill, E.D. and Gill, K.W. (1973). *Vic. Naturalist*. 90, 251.  
 Stearns, H.T. (1974). *Geol. Soc. Am. Bull.* 85, 1189.  
 Ward, W.T. (1973). *Ibid.* 84, 3087.

Part 2 Unpublished work

The Otway coast of Victoria borders a high rainfall forested horst of Lower Cretaceous non-marine strata with short rivers of high declivity. These rivers produce numerous boulders of arkose (greywacke). Being felspathic, the rocks are readily rounded, and have a short "residence time" (for example) with the flint boulders of England or the tough Precambrian rocks of Brittany. The Otway boulders are of low specific gravity compared (for example) with the basalt at Port Fairy further west, so they are moved and abraded more often. An unusual extra source of boulders is the calcitic concretions derived from the Otway Group.

Boulders tend to be concentrated at or near the mouths of rivers. At these same sites are relict boulder beds of Last Interglacial and Holocene ages. The former have no carbonate shells, but the latter have, making  $C^{14}$  dating possible. This note records a series of Last Interglacial boulder beds resting on fossil platforms or occupying ancient gulches. They are commonly overlain by Last Glacial colluvium, which is now stable, being capped with a soil and forest. The tidal range along this coast is about 1 m.



### Last Interglacial Boulder Beds

Northeast to northwest along this coast from Eastern View to Apollo Bay the following sites have been observed:

Eastern View On the north side of Spout Creek the Ocean Road has been recently widened, revealing an emerged platform cut in arkose, and surmounted by a bed of pebbles and boulders of both Lower Cretaceous arkose and Tertiary silcrete. This Upper Pleistocene shore is covered by Lower Tertiary slip material, which fell as the sea retreated because no weathering of the beach deposits has occurred. The slip is therefore late Last Interglacial. The inclusion in the platform of many boulders of silcrete from a paleosol (Upper Tertiary laterite) on top of the high ridge further inland shows that slipping has gone on for a long time. Pieces of angular silcrete up to 1.5 m diameter from the high ridge can now be seen in slip material near sea level; some occurs as beach boulders. The marine boulder bed has nothing to do with the early Tertiary transgression here because that was non-marine (depositional coal) and stillwater in facies. This proof of ancient slips makes suspect stratigraphy based on samples from local roadcuts.

Big Hill Creek Sections beside the beach access track on the N.E. side of the creek show a boulder bed with many angular rocks lying on a flat surface of mottled clayey sand. It is overlain by less weathered alluvium topped by a youthful soil. The boulder bed is at about the same level as the marine boulder beds, and it is interpreted as a fluvial deposit graded to the same sea level.

Reedy Creek This creek is between Big Hill and Lorne. On the N.E. side is a well-developed marine boulder bed (with some pieces of honeycomb weathering) overlying an emerged shore platform cut in bedrock. It is best seen on the track leading to the entrance gates of the property there.

George River In the roadcut on the S.W. side of the mouth is an emerged marine boulder bed occupying an ancient gulch and extending along what is probably the back of a platform. If a platform is present (as seems likely from the cliff sections) it is under the Ocean Road. The boulder bed is about 2 m thick and the lowest boulders exposed are 9 m above M.L.W. (top of *Durvillea* zone).

Sheoak River A boulder bed over an emerged platform cut in bedrock can be seen in the car park on the landward side of the Ocean Road on the S.W. side of the river mouth.

Cumberland River A long outcrop of boulder bed is revealed in a roadcut along the Ocean Road where it faces the sea N.E. of the river mouth, and also where it follows the side of the estuary leading to the bridge (Gill 1972a). One part of the platform surveyed was 7.7 m above M.L.W., but the platform varies in height to the same degree as does the existing one. The boulder bed is covered with a thick layer of stable colluvium surmounted by a soil and forest.



Jamieson River A cutting on the Ocean Road on the N.E. side of the river shows a fossil platform of weathered arkose and siltstone with a pebble bed 0.5 - 0.7 m thick on it. The pebbles are also somewhat weathered. The structure is buried by colluvium.

Boggaley Creek On the inland side of the Ocean Road on the S.W. side of the stream is a boulder bed referred to this series.

S.W. of Boggaley Creek S.W. of this stream is a small point, beyond which is a bay of minor dimensions. A track cut to give access to the beach reveals a boulder bed at the same general level as the others in this series.

Separation Creek Behind the beach is a 3 m terrace of Holocene age, as is shown by its lack of compaction and juvenile soil. Harrington Street ascends from this terrace to the hill behind, and a roadcut in it shows a very well-developed marine boulder bed resting on a weathered siltstone platform.

Wye River The camping ground on the N.E. side of the river is on the 3 m terrace behind the beach. Above it on the landward side is the Ocean Road. In the roadcut is a layer of boulders covered by colluvium. This can be followed towards the bridge where a branch road runs inland beside the river. The same boulder bed can be traced there to a point where the roadcut shows that it rests on an arkose platform. Further inland where the river changes direction, a hillside excavation between the branch road and the river shows the same boulder bed again.

Point Sturt A secondary point on the S.W. side of Point Sturt has a well-developed shore platform (Gill 1972a, b, 1973) above which is a similar emerged platform, the seaward edge of which is 7.5 m above M.L.W. The landward part of this platform remnant is covered with colluvium.

Kennett River Near the bridge on the N.E. side of the river, a cutting on the Ocean Road reveals an emerged shore platform in weathered arkose 3 m above the road level. At one point in the platform there is a small gulch filled with pebbles, boulders and sand. The platform is covered by 2.4 m of rilled mottled clayey sand colluvium capped by a youthful mid-gray columnar soil 15 cm thick.

Carisbrook Creek For some 90 m along the old route of the Ocean Road on the N.E. side of the stream is an emerged shore platform cut in arkose. The inland part of this platform is covered with a boulder bed several boulders thick, and covered with rilled colluvium. The boulders are well rounded, while those in the creek are a mixture of angular and rounded ones, and the rock fragments in the colluvium are angular.

Sugarloaf Between this hill and Whalebone Creek, on a small headland an emerged shore platform has been cut in bedrock between the Ocean Road and the present shore platform. At the landward end is a boulder bed covered with colluvium.



Browns Creek On the N.E. and S.W. sides of the creek, a boulder bed can be seen in Ocean Road sections. The emerged platform on which the boulder bed lies is cut in siltstone, now weathered. Up to 1.5 m of colluvium covers the boulder bed.

Skenes Creek Between the Ocean Road and the beach is a Postglacial 3 m terrace, while inland of the road is an emerged shore platform of weathered arkose. Over the platform is colluvium.

Other sites exist further west on this coast, but have yet to be studied. Some of the boulder beds in this series were discovered by Miss N.H. McHeill of Lorne, who kindly drew them to my attention.

### Chronology

Boulder beds of various ages that retain marine shells and are associated with present beaches, dunes and the 3 m terrace are Postglacial, as is shown by radiocarbon dating (Gill 1973). The emerged marine shore platforms and boulder beds listed above are one eustatic cycle older, are weathered (retaining no shells), and when traced further west to the carbonate facies (marine limestone and aeolinaite) are dated Last Interglacial by U/Th and fossils (Gill 1974). The boulder beds listed are therefore given this age, which also fits what is known of the soil sequence.

Work is progressing in the Snowy River delta by Robert McLennan:

Throughout much of its length of 500 km, the Snowy River flows in a deep valley or gorge. In the 32 km before entering the Southern Ocean, it flows across a flat alluvial plain.

During a major eustatic low sea level probably early in the Pleistocene Period the original valley of the Snowy River was deeply incised into Palaeozoic and Tertiary rocks. In this, it is very similar to the Lower Yarra River (ref. 1). With the rise of sea level the Snowy River built up its valley floor as a delta of fluvial sediments which encroached from the landward end, with simultaneous interfingering of finer sediments from the seaward end.

The Gippsland Lakes system is a product of successive transgressions and regressions of the sea which have built up a triple barrier system that has now become virtually separated from the sea except for an entrance at the eastern end. In opposition to this system and to the east of the Snowy River estuary is Mallacoota Inlet, which is generally accepted as being a drowned River valley. It appears that not only does the Snowy River estuary lie geographically between the other two but that the process by which the form of it evolved is intermediate between the two.

The geology of Western Port Bay, Central Victoria (research by Marc Marsden) provides evidence of changes of sea level.



Pleistocene low sea level(s) Following faulting, downcutting by the sunkland drainage was effected during low sea level(s).

?Last Interglacial higher sea level The Bass River terrace 1 sediments are now overlain by Holocene fluvial and marine sediments, and are therefore regarded as Pleistocene. They could be Last Interglacial (c. 125,000 years BP).

?Last Glacial erosion During a succeeding low sea level, probably the Last Glacial, the terrace 1 sediments of the Bass River were incised. This was followed by a rising sea level that progressively drowned the sunkland.

Holocene higher sea level Evidence for mid-Holocene high sea level, both erosional and depositional, occurs widely in Westernport Bay, and indicates a maximum height above present high-water level of about 1.5 - 2 m. Apparent height variations seen from one locality to another may largely be resolved as time-dependent when dating becomes available, but in Westernport tectonic components must also be strongly considered, both for individual local differences and also with respect to the whole question of regional sea level fall. The time of maximum sea level is taken as 5000 - 6000 years BP.

Other marine erosion evidence for the position of high sea level includes discontinuous but extensive stranded cliff lines, having bases from 1 to 2 m above present high-water mark, often associated with abandoned sediments (South Bass, Churchill Inlet, Cowes Embayment, French Island). A number of rock platforms, lying between 0.7 and 1.5 m above present platforms, have been cut into the cliffs, some having pebble and cobble gravels and sands comparable to the sediments on modern platforms. Shell material may also occur, such as at Chambers Point south of Rhyll, where *Anadara trapezia* and *Magellania* sp. are commonly included.

A variety of small, scattered, abandoned marine deposits is associated with the abandoned cliffs behind the Cowes Embayment and Churchill Inlet. These include sandy, gravelly beach ridges of similar lithologies to the stranded ridges on the Bass Plain, and ribbon-like stranded sand and shelly beach deposits. Many of these are now marked by strands of *Melaleuca*. Abandoned saltmarsh clays etc. are found up to 0.4 m above present level, and sand ridges traversing abandoned saltmarsh possibly represent old strand-lines.

Marine deposition from the time of mid-Holocene high sea level to the present day is marked by a variety of progressively abandoned near-shore and coastal deposits and also by progradation of saltmarsh, mangrove and tidal flats, varying according to local factors of energy, sediment supply and morphology.

New data is available on the Yarra delta (J.L. Neilson, Mines Department):

As part of the investigation for the Melbourne Underground Rail Loop, drilling has recently been carried out along the railway viaduct bordering the Yarra River, between Spencer Street and Queens Bridge.

Tentative conclusions on the relationships between sedimentary formations of the Yarra Delta Group and the Yarra valley basalt flow, suggested by extensive drilling at Jolimont several years ago, have been given further support. As this basalt has been dated radio-metrically as 0.81 million years old from Alphington, some 12 km distant, its relationships with sedimentary formations is important in establishing the chronology in this area.

At Jolimont, directly underlying this basalt were found stiff yellow and grey clays, underlain in turn by sands and gravels, then the Silurian bedrock. The sands and gravels were correlated with the *Moray Street Gravels* and the stiff clay with the *Fishermen's Bend Silt*. Lying upon the basalt surface was a similar stiff clay named the *Jolimont Clay*. Marginal to the basalt was the soft black silty clay of the *Coode Island Silt*, younger than the basalt and presumably the *Jolimont Clay*, though no bore there shows relationship of the *Coode Island Silt* to the *Jolimont Clay*.

The railway viaduct section shows this same basalt flow overlying sands with minor gravels which in turn rest upon Silurian bedrock. These sands are grouped with the *Moray Street Gravels*, and they can be traced more than 1 km southwards beneath Kings Bridge. Sandy and silty clays (stiff) rest on these sands, and are grouped with the *Fishermen's Bend Silt*; one bore gives a clear section through the basalt to sandy clay then sand. This bore and the general spatial distribution provide good evidence of this clay unit occurring beneath the basalt. The *Fishermen's Bend Silt* is accordingly regarded as pre-basaltic in age.

Directly above the basalt along the viaduct section is, as at Jolimont, a stiff silty clay grouped with the *Jolimont Clay*, and where the basalt is absent, this clay commonly rests upon the very similar *Fishermen's Bend Silt* without indication of a break in sedimentation. The basalt thus appears to have been a brief episode which scarcely interrupted sedimentation, and the *Fishermen's Bend Silt* is thus thought to be little older than the 0.81 million years of the basalt. A time interval is only required for the cutting of the channels in the *Fishermen's Bend Silt* which were then filled by the extruded basalt. A radiometric determination on a basalt sample from the viaduct was unsuccessful. The *Jolimont Clay* appears to be little younger than the basalt. Between both *Jolimont Clay* and *Fishermen's Bend Silt* and the overlying *Coode Island Spit*, radiocarbon dated at c. 8300 years BP, lies a major time interval of non-deposition.

Further drilling for engineering purposes, near the Yarra, is awaited.



The sequence of the Yarra Delta in the City area is:

Quaternary	Yarra Delta Group	Coode Island Silt	Soft Black Silty Clay
		Jolimont Clay	Stiff yellow-gray clay and silty clay
		Newer Volcanics Burnley Basalt Flow	Fresh basalt
		Fishermen's Bend Silt	Stiff yellow-grey silty and sandy clay
		Moray Street Gravels	Sand and gravels
Silurian		Siltstone and interbedded sandstone	

South of the Yarra, towards the sea in the Port Melbourne area, the Coode Island Silt, is overlain by the *Port Melbourne Sand*, the uppermost unit of the Yarra Delta Group.

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E.D. Gill