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INTRODUCTION

Australia, New Zealand and Oceania contain considerable lengths of coastline, scattered over a substantial proportion of the globe. Whereas Australia is a mid-plate continent, generally regarded as stable with little evidence of significant Quaternary tectonic deformation (see BRYANT et al., 1988), New Zealand and New Guinea are tectonically active, with some coasts which have undergone rapid uplift, and the Pacific Ocean comprises a series of plate tectonic settings within which there are shorelines that have undergone various rates of vertical movement. In view of the large area, and the variability of tectonic setting, this review is inevitably selective and incomplete.

Several continental or ocean-wide reviews at the beginning of the period serve to set the broad scene for Quaternary shoreline research over this four-year period. The revised, and orbitally-tuned, sea-level curve of CHAPPELL and SHACKLETON (1986), based upon radiometrically-dated reef terraces on the Huon Peninsula, and oxygen isotope measurements on foraminifera from deep-sea cores, has become widely adopted as a global sea-level/ocean volume curve for the last 240,000 years. The state of sea-level research for the Pacific was reviewed by HOPLEY (1987), and it was shown that there appeared to be systematic variation across the Pacific in the time during the mid-Holocene at which modern sea level had been attained. The pattern of sea-level change in Australia, particularly resolution of the course of sea-level change over the last 6,000–6,500 years was reviewed by CHAPPELL (1987), who made a strong case for sea level falling steadily to its present level from a peak 1–2 m above present 6,000–5,500 years BP. The importance of tectonics, especially with respect to New Zealand was examined by BERRYMAN (1987). In addition, the longer-term pattern with respect to these Southern Hemisphere locations has been reviewed by PILLANS (1987).

There have been no major revisions to the general picture contained within these reviews over the last four years. Despite the large area, the fact that this region lies in the far-field of polar ice accumulation and disintegration, has meant that shoreline studies and determination of past sea level have not been complicated by vertical glacio-isostatic adjustments, and a broad envelope of sea-level change during the post-glacial marine transgression (generally similar to that proposed for eastern Australia by THOM and ROY, 1985) can be recognised for the region. However, there has been a continued attention to detail, and particularly to the validity of interpretations of sea level based upon different sea-level indicators. It has become increasingly apparent that detailed local studies, accurately based on specific sea-level indicators, can reveal significant local variations in the chronology or elevations of past sea-level events over the last 6000 years, which can be attributed to more subtle hydro-isostatic adjustments. This has become one major focus of recent research.

There has been a second emphasis on extending the record further back into the Pleistocene, and refining the details within that record. While much of the research in both of these fields has been carried out by workers based in Australia, New Zealand, or the Pacific, there has also been collaboration, particularly with workers in Japan, who are actively engaged in studies in New Zealand, and in the Pacific.

A series of areas in which there has been significant progress can be identified.

GEOPHYSICAL MODELLING

The accuracy of sea-level reconstructions from individual sites is now regarded as such that systematic differences can be used to calibrate geophysical models of adjustments of the crust and upper mantle to altered surface loads (of both ice
and water). While northeast Australia had already been modelled in this way, the last 4 years have seen, firstly assessment of the role of Antarctic ice melt in terms of overall global adjustment (Nakada and Lambeck, 1988), and secondly modelling of the geophysical response of the Australian continent (Nakada and Lambeck, 1989). While this modelling is calibrated using geomorphological observations of past sea levels from selected sites, discrepancies between modelled and observed sea-level events can be important both in refining the model, and in concentrating future sea-level research.

**HOLOCENE EMERGENCE**

There is general agreement that the sea had attained its modern level by mid-Holocene throughout the region. However, the extent to which a mid- or late Holocene sea level above present has been recognised, has increased in recent years. Accurately dated microatolls have been especially important in providing firm evidence of emergence. Evidence for a Holocene sea-level 1–2 m above present is widespread in French Polynesia (Pirazzoli and Montaggioni, 1988; Pirazzoli et al. 1987). Similar evidence has now been reported from several locations in Fiji (Ash, 1987; Miyata et al., 1988; 1990), Austral Islands (Pirazzoli and Veeh, 1987), Cook Islands, (Yonekura et al., 1988; Woodroffe et al., 1990), Guam (Kayanne et al., 1988) and Hawaii (Matsumoto et al., 1988). Similar evidence is also reported from the Cocos (Keeling) Islands, an Australian Territory in the Indian Ocean (Woodroffe et al., 1990). This Holocene high stand of sea level, although widespread, can still not be regarded as ubiquitous throughout the region; it’s occurrence in Tuvalu, for instance, still remains equivocal (McLean and Hosking, 1991).

**TECTONIC DEFORMATION OF SHORELINES**

The rapidly uplifting Huon Peninsula has played an undisputably important role in the interpretation of sea-level variations over the late Quaternary. Interest has continued to focus there (Zhu et al., 1988; Kikuchi, 1990); and in 1988 a detailed, internationally-sponsored drilling program was undertaken on the raised coral terraces in an effort to date terrace development more precisely (Chappell and others).

Detailed studies on the late Quaternary tectonic history of coastal sites in New Zealand are also now available, in many cases based upon more stringent definitions of terrace morphology and better dated deposits (Pillans, 1990). This more rigorous approach may eventually resolve ambiguities which might arise where terrace sequences have previously only been correlated on the basis of number and vertical spacing of features (see Bull and Cooper, 1988; Ward, 1988; Pillans, 1990). Particularly detailed reconstruction of vertical uplift rates has been achieved using the Last Interglacial shoreline, where this can be recognised, as around much of the North Island. Holocene rates of uplift have also been calculated using Holocene marine terraces; these often appear faster than average rates calculated over the late Quaternary. Episodic coseismic uplift history which can be deciphered from the Holocene terraces (Miyauchi et al., 1989; Ota et al., 1991) represents a fine structure which is generally not noticeable in the longer late Quaternary record.

Vertical movements of islands in the Pacific have complicated the recognition of an ocean-wide pattern of sea-level change. Such vertical movements can in some cases be attributed to tectonic activity, as in Fijian islands (Nunn, 1987, 1990). In the case of the island of Hawaii, dating of submerged features has shown the rapid rate of subsidence (2.6 mm/yr) that this still active volcanic island is undergoing (Ludwig et al., 1991). Lithospheric flexure represents a more subtle vertical movement which has led to uplift, perhaps still continuing, of some islands such as the Makatea Islands in the Cooks which have been shown to have been moving at differential rates over the last 200,000 years (Spencer et al., 1987; Stoddart et al., 1990; Woodroffe et al., 1991).

**NEW DATING TECHNIQUES**

The twin objectives of extending the record further into the Quaternary, and refining the details within that record, have led to the careful testing of a series of new dating techniques. While the advantages of AMS radiocarbon and mass-spectrometric U-series dating over the more conventional determination based on these isotopes have yet to be fully realised in relation to shoreline research in the region, other methods have become increasingly adopted. Amino-acid racemisation has been applied with particular success to shells in Australia (Murray-Wallace et al., 1987, 1988, 1990, 1991), and has been used on wood samples from the Pleistocene terraces of New Zealand (Pillans, 1987, 1990). Thermolumines-
cence-dating would appear to offer enormous potential in the determination of the depositional chronology of quartz-rich sand deposits in particular. It has already been applied to some dune environments in Australia and New Zealand (Lees et al., 1990; Bryant et al., 1990; Shepherd and Price, 1990). More extensive dune dating is underway (Lees, Bryant, and others) and the application of TL dating to sands from off the shelf is being explored (Roy, Bryant). U-series dating, while still of enormous value in dating corals (Veeh and France, 1989; Pickett et al., 1989; Woodroffe et al., 1991), has also been applied with some success to the dating of volcanic tephras (Ota et al., 1989), to the dating of iron-rich crusts on shore platforms (Bryant et al., 1990), and with more limited success to the dating of peat (Busell, 1990).

MORPHOSTRATIGRAPHY

The morphostratigraphic approach adopted so successfully to explain estuarine, beach and reef morphodynamics since the early 1980's has been continuing but with less emphasis on these traditional coastal environments. There has been a tendency to move from the shallow and coastal shoreline environment into deeper water, both on the Great Barrier Reef (Marshall and Davies, 1988; Harris and Davies, 1989; GLORIA surveys undertaken from James Cook University and by others), and on the barrier and estuarine systems of southeastern Australia (Roy and Ferland, 1987; Roy and others). There has been a continued emphasis on tropical estuarine systems, with coastal stratigraphic investigations into Northern Territory macrotidal estuaries (Clark and Guppy, 1988; Grindrod, 1988; Woodroffe et al., 1989; Chappell, 1988, 1990), as well as similar research in Queensland (Crowley et al., 1990), and New Guinea (Swadling et al., 1988). This line of research is being extended both in northern Australia (Chappell, Woodroffe and others), and into other deltaic environments of northern New Guinea and the Gulf of Papua (Chappell and others).

Similar morphostratigraphic research has continued in South Australia (Short et al., 1989; Belperio and others), and in New Zealand (Brown and Wilson, 1988). The periodicity of chenier formation in northern Australia has been examined (Lees, 1987; Lees and Clements, 1987; Short, 1989). The development of cliffs has received some attention (Bird, 1990; Nott, 1990). The record of dune development has also been examined, particularly at a series of sites around Australia (Bird, 1988; Chapman, 1989; Coventry, 1988; Ward and Grimes, 1987, 1988; Hesp, 1988; Hesp and Thom, 1989; Lees et al., 1990; Short, 1988). Reef morphostratigraphy is being examined in the the Cocos (Keeling) Islands (Woodroffe et al., 1990, 1991), and in the Abrolhos (Collins, Wyrmoll and others).

HUMAN IMPACT ON COASTS: THE GREENHOUSE EFFECT

The late Quaternary development of many coastlines has occurred while those coastlines have represented important resources for human populations. It is becoming increasingly clear that human activity has had an impact on depositional and erosional processes which cannot always be disentangled from natural geomorphological processes. In this area of study, geomorphologists are beginning to work more closely with anthropologists and archaeologists, particularly in the Pacific Islands (Swadling et al., 1988; Nunn, 1990, 1991).

Perhaps the greatest area for concern about human impact on coastal development lies with the issue of sea-level rise which is considered a likely consequence of global warming, termed 'the greenhouse' effect. Within Australia there has been a healthy skepticism about the more extreme 'predictions' of the projected rate of sea-level rise (Bryant, 1988; Belperio, 1989), and a greater willingness to embrace the more conservative estimates of sea-level rise which have been generated as a result of the latest modelling.

At the Greenhouse conference convened in Melbourne in 1987, the impact of sea-level change was a major item of discussion (Bird, 1988; Cocks et al., 1988; Hopley and Kinsey, 1988; Short, 1988), and the Quaternary perspective of past adjustments was a prominent theme (Thom and Roy, 1988). The issue of coastal response to climatic change has been addressed at the national level in Australia (Thom, 1989), and the National Greenhouse Advisory Committee has funded two major coastal research initiatives, one into Quaternary palaeoenvironmental reconstructions (coordinated by Chappell), and one into using coastal landforms and biota to monitor change (coordinated by Thom).

Perhaps those coastlines upon which projected sea-level rise might have the greatest impact are on the low-lying islands of the Pacific. In particu-
ular several nations (Kiribati, Tuvalu, Marshall Islands) are composed entirely of coral atolls on which the highest land rises only 3–4 m above high tide level, or less. A series of studies has examined the likely impact of sea-level rise on these island nations (Connell and Roy, 1989; Nunn, 1991; Roy and Connell, 1989, 1990; Spennemann et al., 1989; Sullivan and Pernetta, 1989).

The greenhouse scenario has provided a context within which past and ongoing Quaternary shore-line research in the region is both prominent and relevant, and it seems likely that sea-level research in particular will become much more clearly focused over the next decade.

REFERENCES


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