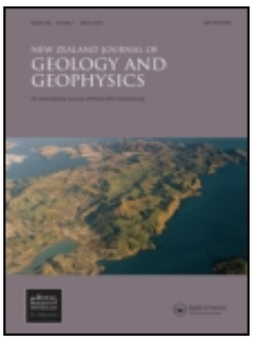

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POST-GLACIAL SEA LEVELS OF NORTHLAND AND AUCKLAND

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ABSTRACT

In post-glacial time, either sea level has been a maximum of 2 m above the present level or there has been epeirogenic uplift without tilting over a distance of 270 km in the Northland and Auckland regions. The former alternative is preferred.

INTRODUCTION

Within the Northland–Auckland area (Fig. 1), beach ridges at Miranda have already been described (Schofield 1960). They have three well-preserved morphological details useful in determining past sea levels: high-spring-tide berm, storm ridge, and mean-high-tide estuarine flats. The results (Fig. 2, Profile 1) showed a sea-level high of +2·1 m, 3,900 years ago, since when the sea has fallen to today's level in a fluctuating manner. Because the existence of a post-glacial sea level higher than the present is controversial (Newman 1968), the examination of beach-ridge systems has been extended 270 km north and 55 km east from Miranda to see if the Miranda results are local or regional. Air photos were used for plotting traverses, and a surveyor's level and staff were used for determining heights. At the four new localities the beach ridges are not as well preserved as those at Miranda because they are commonly covered by wind-blown sand. Thus it has not been possible to determine past sea levels with the same accuracy. However, apart from narrow coastal strips of high foredune, the wind-blown sand has not obliterated the beach ridges completely. There is sufficient of their form left, together with radiocarbon dates and internal stratigraphy, to show sea-level change has probably been the same at each locality.

DESCRIPTION

Matauri Bay (Fig. 2, Profile 2)

The section lies centrally across post-glacial ridges within the bay-head fill of Matauri Bay. Modern beach deposits consist of sand with some gravel up to high tide level; gravelly sand with coarse shell in the high-spring-tide berm and storm ridge; and dune sand with fine shell thinly covering older deposits behind the storm ridge. The dune sand, together with ancient Maori ridge-like cultivations make it difficult to interpret the beach ridges, so that only the highest, which is also one of the earliest, was looked at in detail.

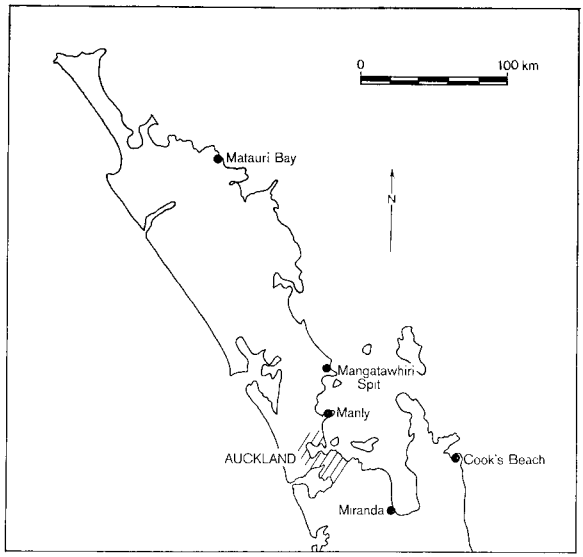
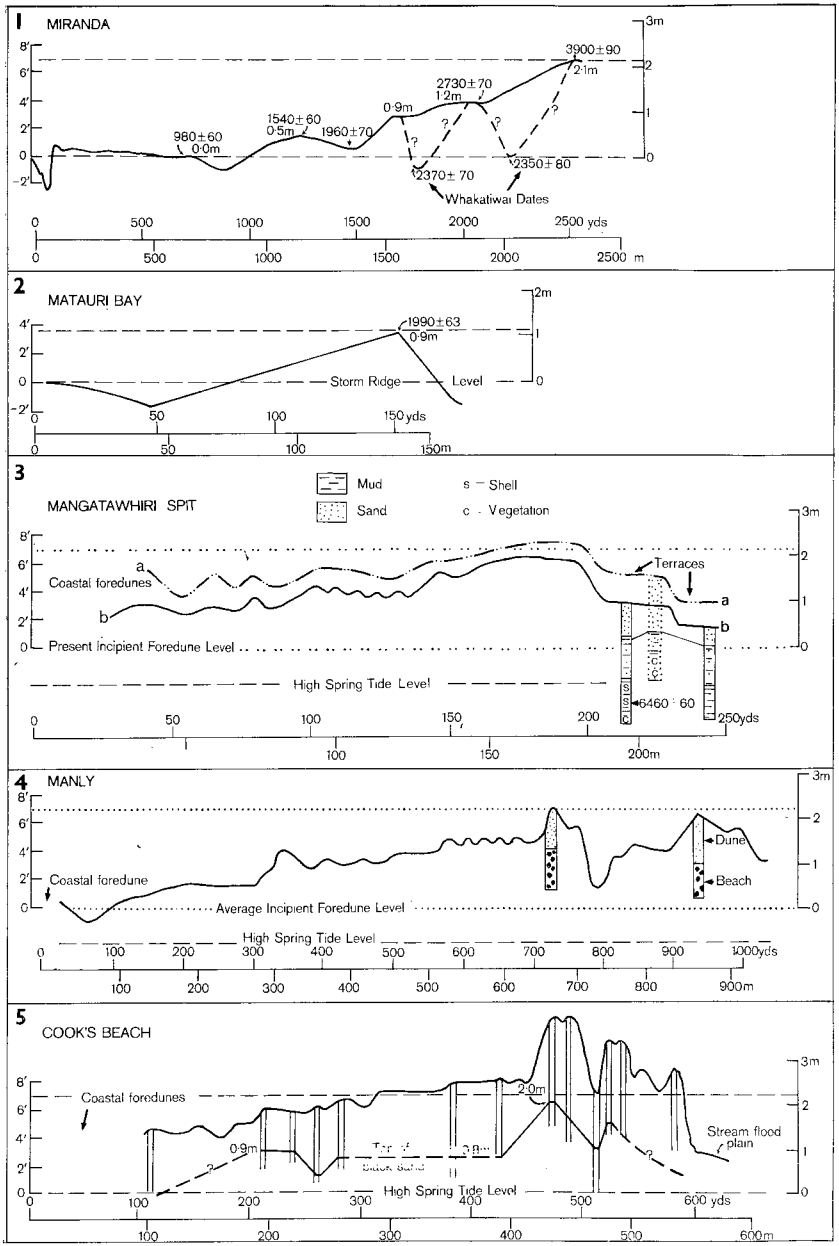


FIG. 1—Northern North Island, New Zealand, with locations of beach ridges discussed in this paper.

At the northern end of the highest beach ridge, where it is disturbed by Maori occupation, a post-hole bore showed 0·5 m of unweathered sand overlying 0·25 m of black pebbly sand with charcoal which in turn overlies loose gravel. At its southern end, this beach ridge is underlain by an undisturbed immature soil. This consists of an 0·25 m thick "A" horizon in fine sand with comminuted shell fragments, which grades downwards into a "C" horizon of sand with rare pebbles, more than 1·3 m thick. The topmost fine sand with comminuted shell fragments is interpreted as a thin layer of dune sand which is overlying a storm ridge, the crest of the latter being 0·9 m above its modern analogue. Whole shells collected from an outcrop at the southern end of this ridge and 2·8 m below its crest, yielded an age of 1,990 ± 63 yr B.P. (NZ731). Both the interpreted sea level, +0·9 m, and age for this ridge are similar to a ridge in the Miranda traverse which represents a +0·9 m sea level and which has been dated (NZ268, NZ269) between 1,960 ± 70 and 2,370 ± 70 yr B.P. (Fig. 2, Profile 1).

FIG. 2—Beach profiles; present shore at the left side of each profile. Approximate time correlation is provided by using individual horizontal scales. The Miranda curve is corrected from Schofield (1960) after Schofield & Thompson (1964). The precise sea levels represented by the Whakatiwai dates are not certain, but there could well have been a sea-level low prior to 1,990 years ago as is shown by decrease in height with increasing age of 9 distinct storm ridges prior to the 1,990 year old ridge at Matauri Bay. Curves a and b, Profile 3, represent two traverses as shown in Fig. 3.


1
MIRANDA
3900±90
2·1m
2730±70
1·2m
0·9m
1540±60
0·5m
1960±70
980±60
0·0m
2370±70
2350±60
Whakatiwai Dates
0 500 1000 1500 2000 2500 yds
0 500 1000 1500 2000 2500 m
2
MATAURI BAY
1990±63
0·9m
Storm Ridge
Level
0 50 100 150 yds
0 50 100 150m
3
MANGATAWHIRI SPIT
Mud
Sand
s – Shell
c – Vegetation
Coastal foredunes
a
b
Terraces
Present Incipient Foredune Level
High Spring Tide Level
6460 ± 60
0 50 100 150 200 250yds
100 150 200m
4
MANLY
Coastal foredune
Dune
Beach
Average Incipient Foredune Level
High Spring Tide Level
0 100 200 300 400 500 600 700 800 900 1000yds
100 200 300 400 500 600 700 800 900m
5
COOK'S BEACH
Coastal foredunes
2·0m
0·9m
Stream flood plain
High Spring Tide Level
0 100 200 300 400 500 600 yds
100 200 300 400 500 600m

Mangatawhiri Spit (Fig. 2, Profile 3; and Fig. 3)

Observations of the modern beach over many years show that there is usually a high-spring-tide berm that changes in width from one season to another and a slightly higher berm which consists of wind-blown sand on top of the high-spring-tide berm. The higher berm is an incipient foredune which may or may not ultimately develop into a full foredune. Most of the 4 km long Mangatawhiri Spit is covered by dunes except at its southern end where beach ridges are tightly packed for a distance of 180 m behind a narrow strip of foredunes (Fig. 3). The ridge furthest inland is the highest. Beyond it lie two small inland-facing terraces that separate it from a swamp.

The beach ridges are low rises with no topographic details that can be used to separate high-spring-tide from storm or wind-blown deposits. However, it is probable that most are covered by some wind-blown sand as is shown by a constant downward increase in grain size between 0·3 and 0·6 m below the surface in seven drillholes drilled along traverse **b** (Fig. 3). Furthermore, the greater heights of the ridge tops within the westernmost traverse **a** (Profile 3a) compared with those of their continuations within the easternmost traverse **b** (Profile 3b), are almost certainly due to a greater supply of wind-blown sand as the thick dunes are approached to the northwest (Fig. 3).

The modern incipient foredune is on average 0·7 m above the modern high-spring-tide berm, and its level is accepted as the datum for calculating past sea levels represented by beach ridges in this area. On this datum the highest sea level was approximately +2 m.

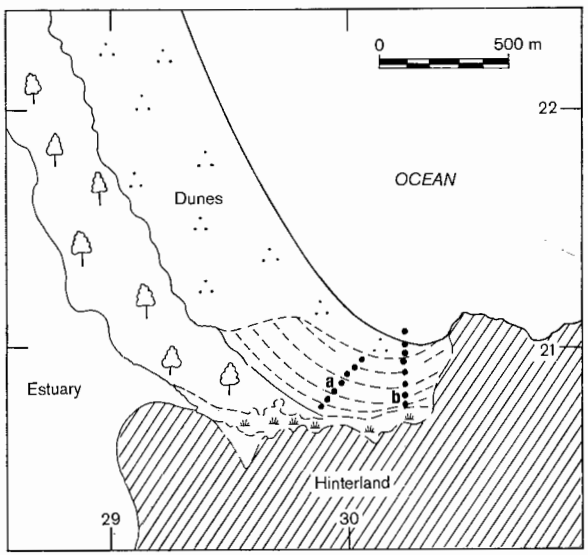


FIG. 3—Locality plan of traverses at southern end of Mangatawhiri Spit.

No datable material was obtained from the ridges but their immature soils show that they are post-glacial in age. Drillholes in the terraces immediately behind the highest ridge (Fig. 2, Profile 3) show up to 1 m of sand overlying 0·9 m of muddy, carbonaceous sand which in turn overlies a shelly mud the top of which is 0·6 m above mean high tide. Shells from the shelly mud are dated as 6,460 ± 60 yr B.P. (NZ833). They include (Dr C. A. Fleming pers. comm.):

Nucula hartvigiana Dohrn
Barbatia novaezelandiae (Smith)
Chlamys cf. *zelandiae* (Gray)
Mylitella cf. *vivens* Finlay
Chione (*Austrovenus*) *stutchburyi* (Gray)
Tawera sp. (v. worn)
Notirus reflexus (Gray)
Myadora striata (Quoy & Gaimard)
Zediloma (*Fractarmilla*) *subrostrata* (Gray)
Zethalia zelandica (Adams)
Cellana sp.
Zeacumantus lutulentus (Kiener)
Maoricolpus roseus (Quoy & Gaimard)
Sigapatella novaezelandiae Lesson
Zeacrypta monoxyla (Lesson)
?Axymene sp.
Austromitra rubiginosa (Hutton)
Amphibola crenata (Martyn)

This is a mixed assemblage from a variety of environments, including lagoonal and offshore. Mr R. V. Grace, who has studied the modern shell-beds of this region, concluded that the sample was too small to determine the precise environment of deposition, but that it was probably deposited in shallow water or intertidally, and that it was probably mainly under lagoonal influence, but nearer the entrance than the head of the lagoon. The mean tidal range is approximately 3·5 m. The top of the shell bed is at 0·6 m above mean high tide, and thus if it is an intertidal deposit, it indicates a sea level of −1·1 m to + 2·3 m at the time of its formation.

Manly (Fig. 2, Profile 4; Fig. 4)

The present coast consists of a foreshore that slopes gently from low tide up to a berm at high-spring-tide level. In places a grass-covered berm, an incipient foredune, lies from two-thirds to one metre above the high-spring-tide berm and in front of a 2 m high foredune. Both foredune and incipient foredune are underlain by loose wind-blown sand which is distinct from the firm, water-laid, foreshore sand.

Older ridges, behind the foredune and up to nearly 1 km inland, generally have flat tops like the present high-spring-tide berm, but are covered by wind-blown sand up to 1 m thick which causes crests to be slightly undulating. No wood or shell is available for dating but the poorly developed soils show that the ridges are post-glacial in age. The difference in compaction between the wind-blown and water-laid sand was used in determining the dune cover on the highest ridges which shows that the highest beach is at least 2 m above its modern counterpart.

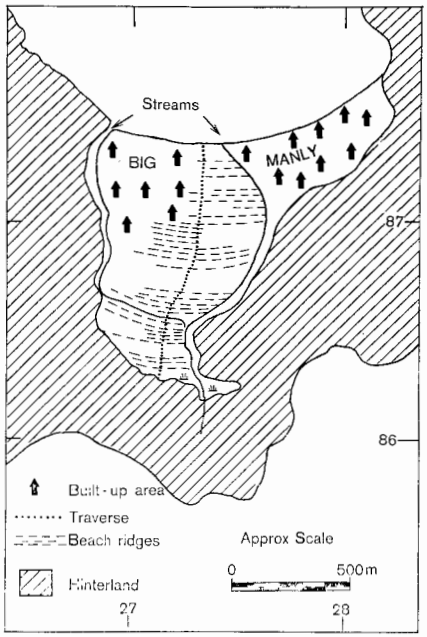


FIG. 4—Locality plan of Manly traverse

Cooks Beach (Fig. 2, Profile 5; Fig. 5)

Within the first 100 m from the shore, foredunes, which presumably covered beach ridges, have been levelled by man (Fig. 5). Further inland the typical ridge and swale topography is preserved, but wind-blown sand from 1 to 2 m thick has made the ridge surface irregular so that it is impossible to detect with certainty what is a high-spring-tide berm, storm ridge, or incipient dune. No shell or wood has been found for dating, but the ridges are coated by a typical post-glacial soil consisting of a 0·23 m-thick "A" horizon on a 0·3 m, slightly oxidised "C" horizon.

A number of drillholes encountered concentrated black-sand which is found along the present Cooks Beach and nearby beaches only between mean-high-water and high-spring-tide wash marks—particularly along the latter level. (In one small area, where the protective foredune had been levelled, a recent storm had concentrated black-sand at a level of 0·15 m above high-spring-tide wash mark level.) Modern black-sand concentration is also patchy and thus it is not surprising that in some ridges more than one hole was required before it was encountered. Furthermore, its absence in the holes near both ends of the traverse need not mean that sea level was below the present water table (limit of drilling) as is inferred in Fig. 2. Because of such uncertainties, the sea level curve for Cooks Beach is not considered as good as that for Miranda, but, like the latter, it shows an early +2 m level, since when sea level has fallen in a fluctuating manner.

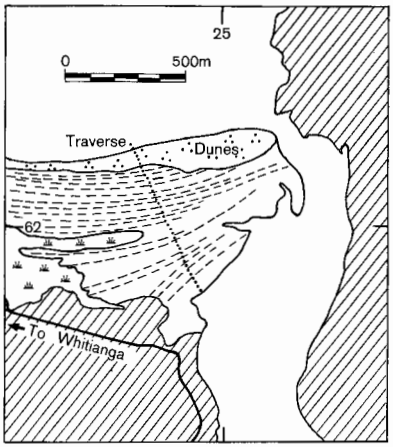


FIG. 5—Locality plan of traverse at eastern end of Cooks Beach.

CONCLUSIONS

Four of the areas investigated fall within a region 110 km long and 55 km wide. The highest post-glacial beach ridge of each of these areas represents a +2 m sea level and, as it always appears early in the post-glacial beach-ridge systems, it is inferred to be of the same age. The +2 m sea level at Miranda has been previously dated (NZ272) at 3,900 ± 90 yr B.P. (Schofield 1960). At Mangatawhiri Spit a shell bed formed prior to the highest ridge has been radiocarbon dated (NZ833) at 6,460 ± 60 yr B.P.

At Matauri Bay, 170 km further north, i.e., 270 km north of Miranda, the highest beach ridge represents a +0·9 m sea level and its age (NZ731), 1,990 ± 63 yr B.P., is probably the same age as the 0·9 m sea level recorded from Miranda. Holocene surfaces in this northernmost region (Kear & Hay 1961) show that sea level was almost certainly a maximum of about +2 m, which, together with the correlation of the Matauri and Miranda evidence for the +0·9 m level suggests that the apparent post-glacial sea-level changes have been consistent over a distance of at least 270 km. Either there has been epeirogenic movement, without tilting, over this distance or local sea level has risen eustatically a maximum of +2 m in post-glacial times. The latter alternative is preferred.

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