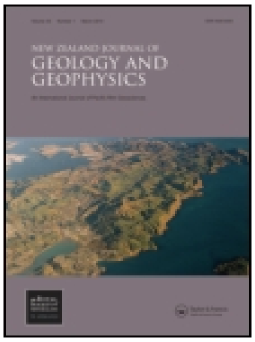

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Abstract Holocene coastal plains preserved at Aramoana and Pourerere, eastern North Island, are subdivided into three levels (T1, T2, and T3) at Aramoana and two levels (TH and TL) at Pourerere. Infilled valley features, presence of estuarine silt, and radiocarbon age of shells in estuarine deposits (7530 ± 100 yr B.P. at Aramoana and 7330 ± 70 yr B.P. at Pourerere) indicate that T1 and TH were formed in association with postglacial sea-level rise. A radiocarbon age of 5850 ± 80 yr B.P. from deposits on T1 suggests that its emergence was at about 6000 yr B.P. Shells from T2 are dated at 5400 ± 90 yr B.P. and shells from T3 are dated at 3200 ± 35 yr B.P. It is likely that T3 is correlated to TL. The formation of the sequence of marine terraces is considered to be the result of episodic uplift due to large earthquakes. Aramoana and Pourerere coastal plains must lie on a separate structural block from Waimarama to the north, because there are no Holocene marine terraces with a common date of uplift.

Keywords Holocene; marine terraces; postglacial sea-level rise; uplift rate; coseismic uplift; Aramoana; Pourerere; radiocarbon dates

INTRODUCTION

The eastern North Island, New Zealand, is part of the rapidly deforming accretionary borderland that extends westward from the Hikurangi Trough to coastal areas (Fig. 1; Cole & Lewis 1981). Recent tectonic movement is recorded by Holocene terraces along the coast. Holocene transgressive deposits are well preserved at river mouths throughout the east coast, and local differences in uplift rate have been established on the basis of terrace ages and height distribution (Ota et al. 1988). A series of Holocene marine terraces is in many places preserved at elevations below the Holocene terrace underlain by the transgressive estuarine deposits. These terraces are considered to be a result of repeated coseismic uplift (Berryman 1983; Ota et al. 1983; Hull 1987; Ota 1987; Berryman et al. 1989).

A narrow Holocene lowland is developed along the rivers at Aramoana and Pourerere (Fig. 1). Modern shore platforms expose Miocene calcarerous sandstone at Aramoana, and Cretaceous sandstone and siltstone at Pourerere (Kingma 1962), and older Holocene marine terraces have been cut into these rocks.

The purpose of this paper is to describe, date, and evaluate the uplift history of Holocene marine terraces at Aramoana and Pourerere, Southern Hawke's Bay. Despite the small area of preserved terraces, these localities provide the only locations from which to evaluate Holocene vertical tectonics through the 100 km long coastline between Waimarama (Miyauchi et al. 1989) to the north and Cape Turnagain to the south. This study is part of a research project on Holocene coastal tectonics of eastern North Island, New Zealand (Ota 1987; Ota et al. in press).

STUDY METHOD

Geomorphological sketches were prepared from interpretation of aerial photographs (1:15 840 scale). The Holocene stratigraphy was established from natural exposures and hand-augered cores taken in October 1985. Shells were collected for radiocarbon dating by N.Z. Institute of Nuclear Sciences (Table 1). Species identification and environmental analysis of shell samples was also carried out (Beu in press). Heights of terraces and various levels of terrace deposits were obtained by levelling (Electric Distance Meter) and corrected to the height above mean sea level (a.m.s.l.), using daily tide table at Napier and the nearest secondary port (Porangahau).

MARINE TERRACES AT ARAMOANA

Terrace morphology

At Aramoana, c. 10 km north of Blackhead Point, three distinct Holocene marine terraces (T1, T2, and T3) have been mapped (Fig. 2 and 3). The highest, T1, is the most extensive and can be traced inland along the Ouepoto Stream. This terrace contains a series of beach ridges and attains a maximum altitude of c. 10 m. A 2.6 m high riser, parallel to the present coastline, separates T1 from T2, which is 5.8 m a.m.s.l. at its inner edge. A beach ridge is also preserved on the T2 terrace. The lowest terrace, T3, is parallel to T2 and is accompanied by a series of beach ridges. T3 occurs primarily to the north of the Ouepoto Stream and its inner edge is 2.8 m a.m.s.l. T3 is fringed by a sandy beach. Below T3, a wide beach extends along the coast,

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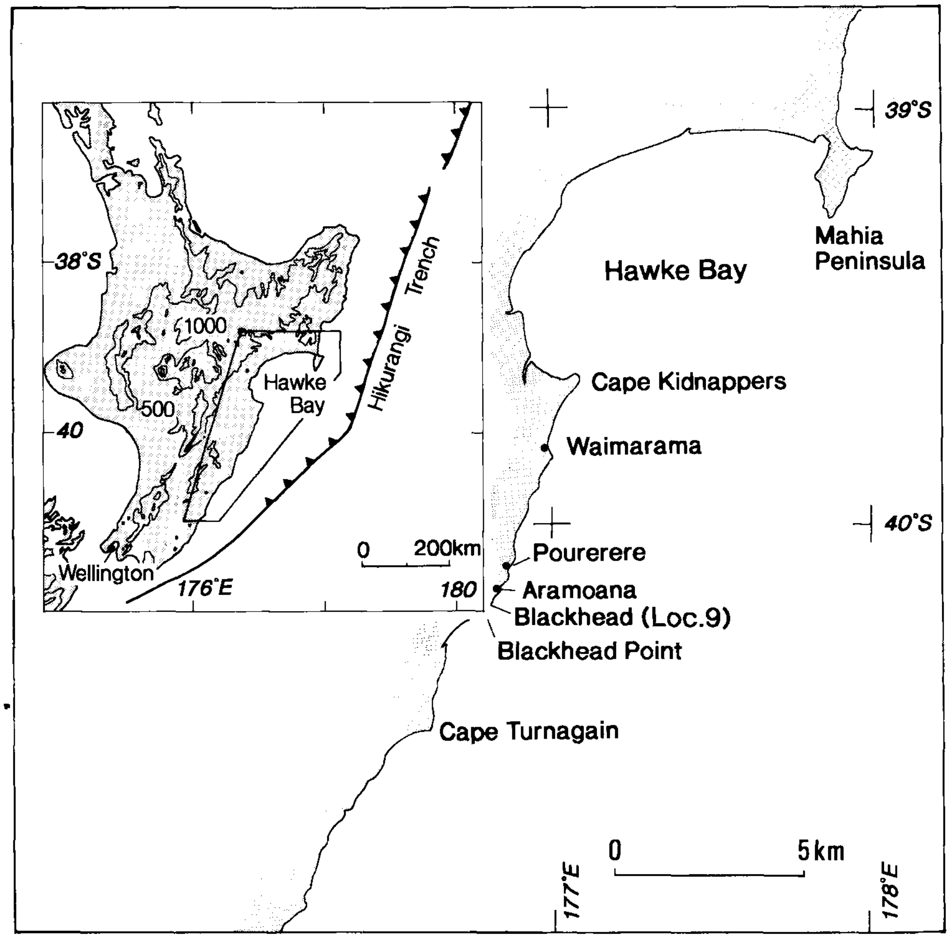


Fig. 1 Location of places discussed in the text. Inset shows setting of North Island, New Zealand. Elevation in metres.

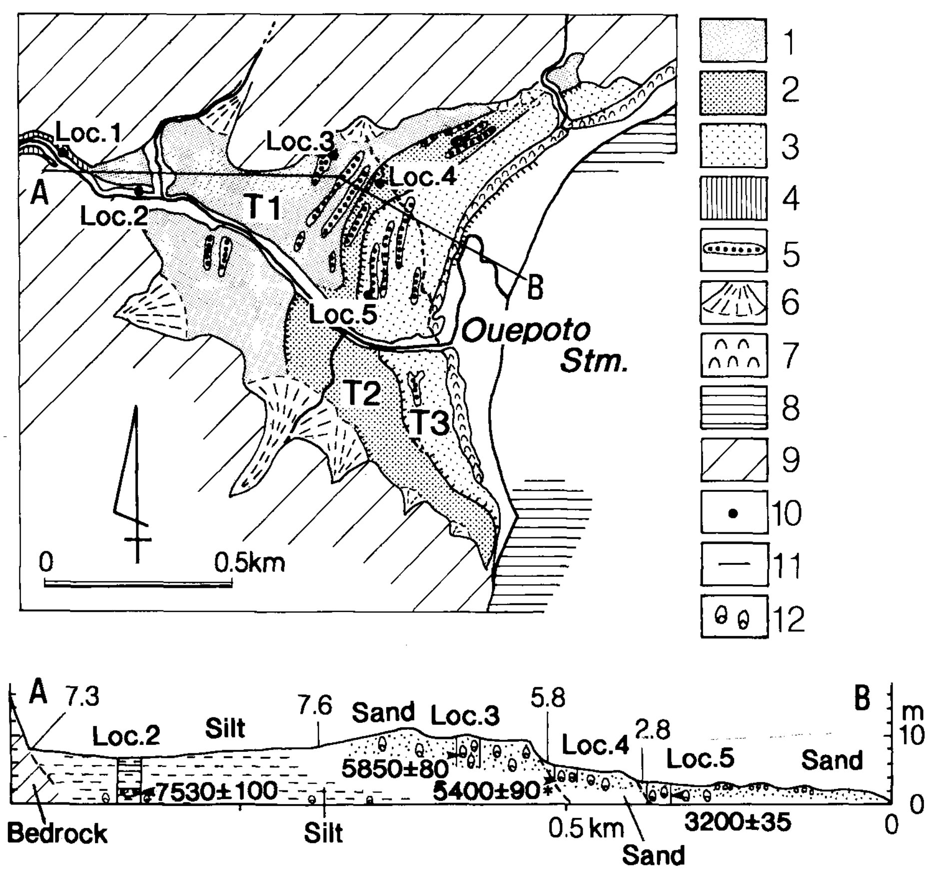


Fig. 2 Geomorphological map of the Aramoana area with topographic and geologic section A–B. 1, higher terrace (T1, TH); 2, middle terrace (T2); 3, lower terrace (T3, TL); 4, fluvial terrace; 5, beach ridge; 6, alluvial fan; 7, sand dune; 8, wave-cut bench; 9, mountain and slope; 10, location of stratigraphic section; 11, location of profile; 12, shell. Figures on the profile are height above mean sea level (metre).

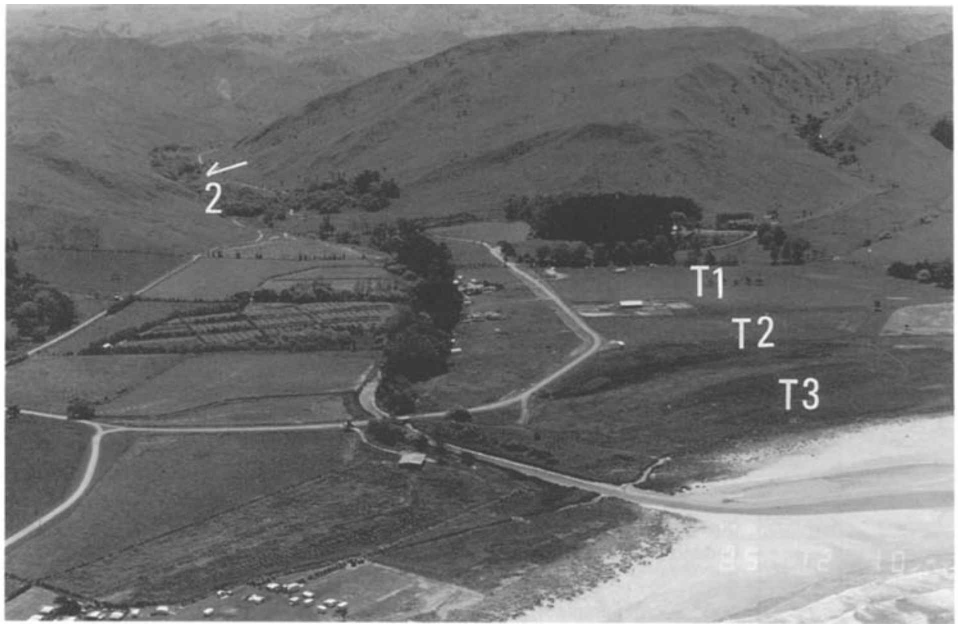


Fig. 3 Oblique airphoto of the Aramoana area showing Loc. 2 and Holocene marine terraces.

and continues southward to Blackhead. The inner part of this lowest beach is probably uplifted. Topographic and geologic information is given in the cross-section A–B (Fig. 2) together with radiocarbon dates. Representative columnar sections are shown in Fig. 4.

Terrace stratigraphy and radiocarbon age

A blue-grey silt, including shells in growth position, is exposed at the innermost part of T1 on the left bank of the Ouepoto Stream (Fig. 2, Loc. 1 and 2). Shells are mostly *Austrovenus stutchburyi*, which is a typical shallow estuarine species. Shells from Loc. 2 are dated at 7530 ± 100 yr B.P. We infer that T1 was formed in association with the postglacial sea-level rise, judging by the infilling valley features, presence of estuarine silt with shells in growth position, and the radiocarbon age of the shells. Since these estuarine deposits are overlain by fluvial deposits, probably with a minor unconformity at Loc. 1 and 2, the exact height of marine limit is uncertain. The apparent upper limit is 1.2 m a.m.s.l. at Loc. 2, but it shows only the minimum height. The true marine limit is probably c. 6–7 m, based on the surface height of the extensive part of T1 (Fig. 2). Shell fragments from a beach ridge (Loc. 3) are composed of various kinds of shells and the ridge is considered to have been deposited at an open, exposed shore. Radicarbon age of these shells at 6.1–8.5 m a.m.s.l. is 5850 ± 80 yr B.P., which is probably close to the age of the culmination of postglacial sea-level rise.

The radiocarbon age of shell fragments at 4.3–5.4 m a.m.s.l. from Loc. 4 at T2 is 5400 ± 90 yr B.P. This age may be uncertain, because Loc. 4 is very close to the higher terrace (T1) and it is possible that some materials eroded from T1 may have been incorporated into the lower terrace (T2) deposits. At Loc. 5 on T3, shell fragments of an exposed rocky shore species (Table 1) were found in the well-sorted marine sand that underlies T3. These are dated at 3200 ± 35 yr B.P.

Table 1 Radiocarbon dates and shell fauna from marine terrace deposits.

Localty no.	Field no.	Grid reference[1]	Fossil record no.	Species[2]	Ecology	^{14}C date[3] (yr B.P.)	NZ Code no.	Sample height (m a.m.s.l.)	Remarks
2	156–2	V23/366601	V23/f59	*Austrovenus stutchburyi* *Macomana liliana*	Estuarine	7530±100	7136A	0.4	Terrace 1, Aramoana
3	165–1	V23/372112	V23/f61	Fragments of various species.	Intertidal to high tidal, exposed rocky coast	5850±80	7167A	6.1–8.5	Beach ridge on Terrace 1, Aramoana
4	162–1	V23/373111	V23/f62	Fragments of various species including fresh fragments of *Austrovenus stutchburyi*.	Intertidal, exposed rocky shore	5400±90	7092A	4.3–5.4	Terrace 2, Aramoana
5	166–1	V23/372107	V23/f60	*Turbo smaragdus* and fragments of various species.	Intertidal, exposed rocky shores	3200±35	7119A	0.8–2.4	Terrace 3, Aramoana
6	175–1	V23/392162	V23/f63	*Austrovenus stutchburyi* *Macomana liliana* *Amphibola crenata*	Estuarine	7370±70	7129A	2.2–2.9	TH (higher terrace) Pourerere
9	141–1	V23/369090	V23/f67	Fragments of various species.	Mid–low tidal, exposed rocky shore	286±65	7414A	1.1	Lowest terrace, Blackhead

[1]NZMS 260 1:50 000.
[2]All shell identified and ecology determined by A. Beu, DSIR Geology & Geophysics.
[3]Ages calculated by Libby T^{1}/2 (5568 yr). All shell ages calculated with respect to N.Z. shell standard: Δ^{14}C –41‰: ± 1 SD of counting statistics.

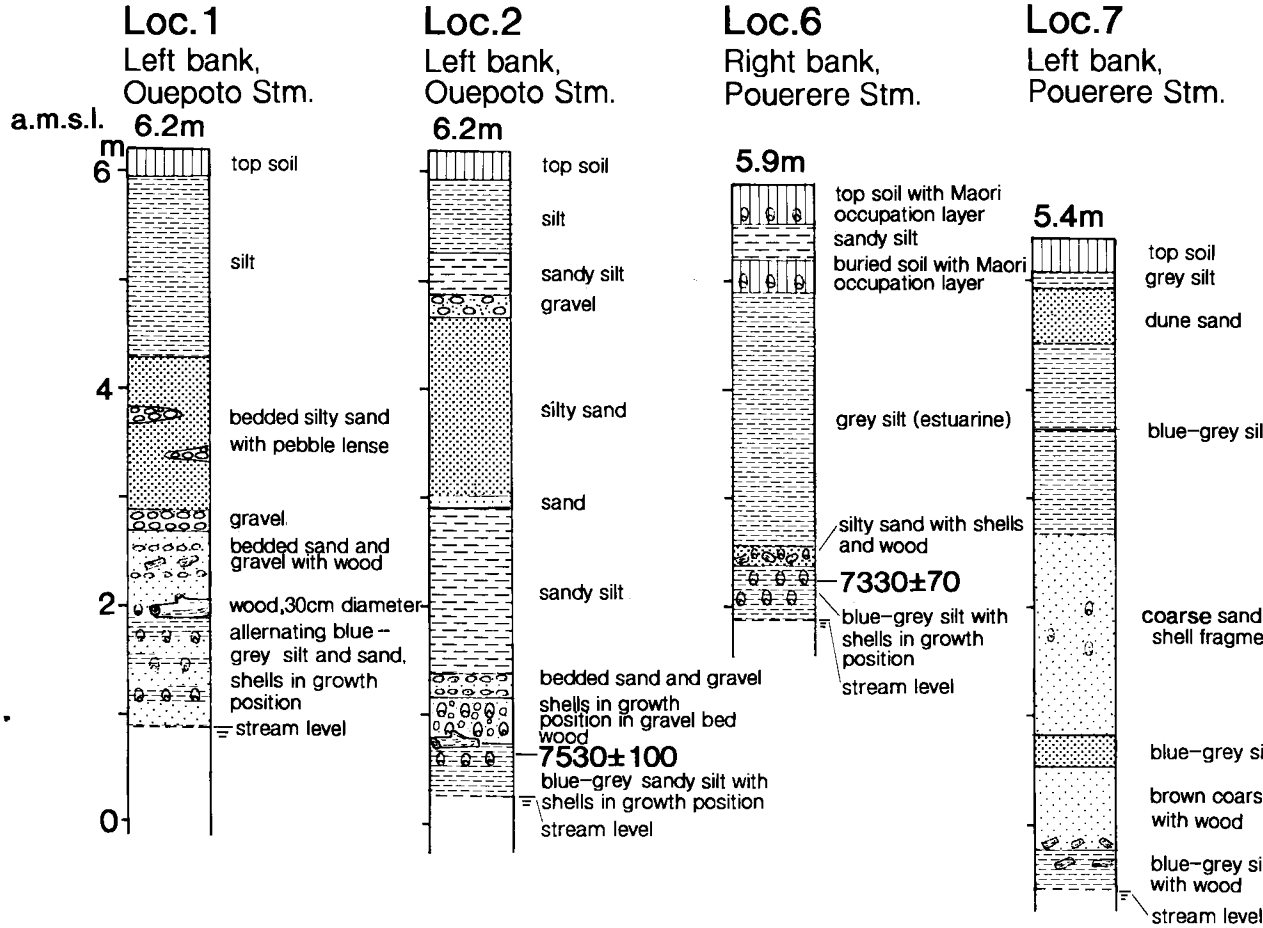


Fig. 4 Representative columnar sections of Holocene transgressive deposits at Aramoana and Pourerere.

MARINE TERRACES AT POURERERE

Terrace morphology

At Pourerere, about 6 km north of Aramoana, two terraces are developed in the valley now occupied by the Pourerere Stream (Fig. 5). The higher terrace (TH) is widely preserved and is traceable inland along streams, suggesting infilling of a valley. Its inner margin is c. 9 m a.m.s.l. There is a 3 m high riser between the higher terrace and lower terrace (TL), which is limited to the right bank of the Pourerere Stream. The inner margin of TL is 2.6 m a.m.s.l. Small remnants of fluvial terraces exist below TH along the Pourerere Stream.

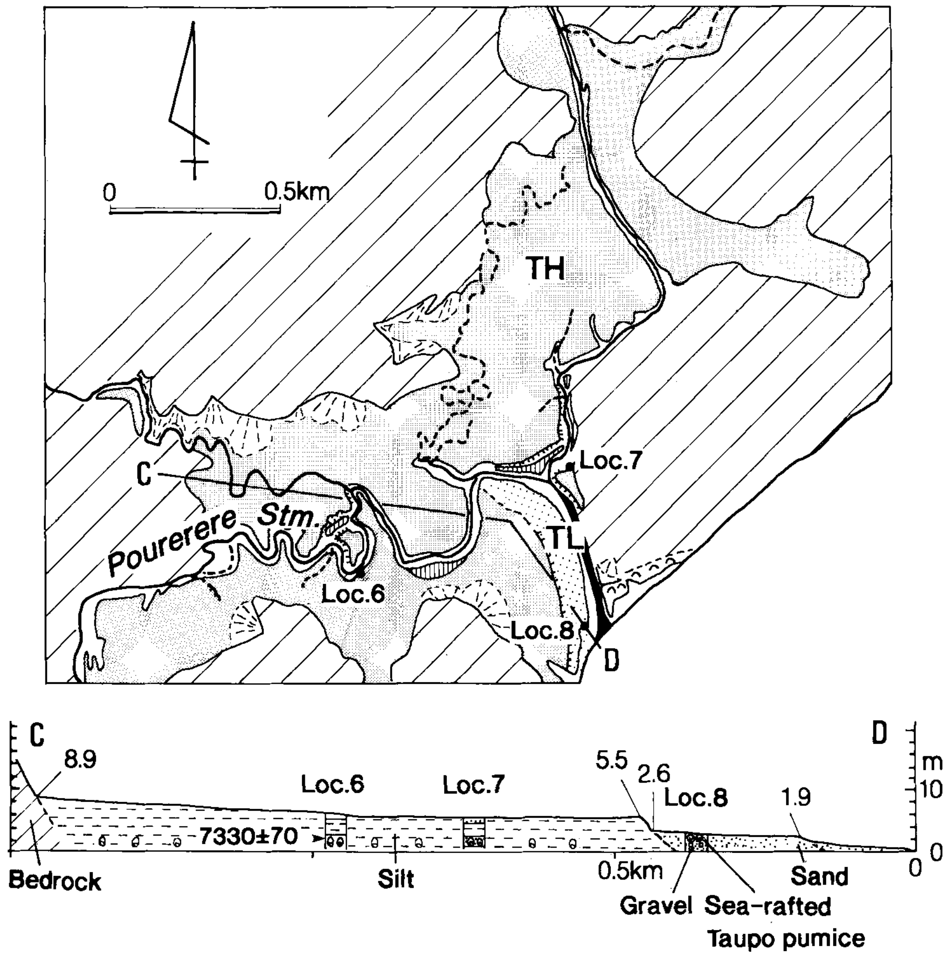
Terrace stratigraphy and radiocarbon age

Approximately 750 m inland from the present shoreline, *Austrovenus stutchburyi* and *Macomona liliana*, both in life position and within blue-grey silt at 2.2–2.9 m a.m.s.l., have been dated at 7330 ± 70 yr B.P. An apparent marine limit at this locality is c. 5 m (Fig. 4). The facies and radiocarbon age of TH at Pourerere are very similar to those of T1 at Aramoana. T1 and TH are, therefore, correlated. TL is underlain by shelly sand and gravel at least 0.5 m thick. Several pieces of sea-rafted Taupo Pumice exist on the top of beach deposits, suggesting a minimum age for emergence of TL. No datable material was found from TL. It is likely, however, that TL can be correlated with T3 of Aramoana, judging by their similarity in height.

DISCUSSION AND CONCLUSIONS

1. Postglacial transgressive deposits that are overlain by the highest Holocene terrace are identified at Aramoana and Pourerere. The coastline at the time of the culmination of postglacial sea-level rise was located about 1 km inland from the present coast at Aramoana and at least 1 km inland from the present coast at Pourerere. An average uplift rate of c. 1.4 m/1000 yr at Aramoana and Pourerere, is indicated on the basis of radiocarbon age and sample height (7530 ± 100 yr B.P. at 0.4 m a.m.s.l. at Loc. 2 and 7330 ± 70 yr B.P. at 2.2–2.9 m at Loc. 7) and accepting the eustatic Holocene sea-level curve (c. –10 m at c. 7500 yr B.P. and c. –8 m at c. 7300 yr B.P.) of Gibb (1986).
2. The striking difference in preservation of T1 and TH shown in Fig. 2 and 5 is probably related to a difference in drainage pattern in both areas. Conspicuous estuaries were formed only at the Pourerere area where streams have rather gentle slope and flow out to an open sea through a narrow inlet. The presence of two lower marine terraces parallel to the coast in the Aramoana area also reflects different morphology of the original coastal configuration of these two areas.
3. The presence of lower terraces separated by prominent risers indicates that some episodic uplift probably took place in the study area, similar to the episodic uplift documented in other areas of east coast, North Island (e.g., Berryman et al. 1989). The limited number and height of

Fig. 5 Geomorphological map of the Pourerere area with topographic and geologic section C–D. Legend is same as Fig. 2.



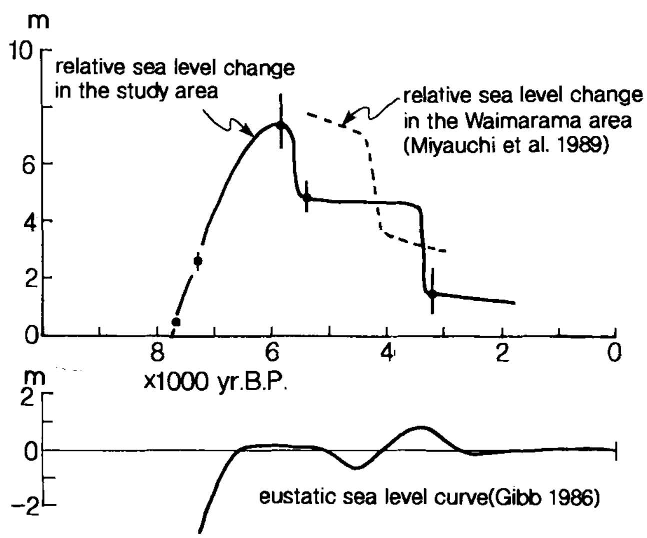


Fig. 6 Relative sea-level curve for the study area, assuming that Aramoana and Pourerere lie on the same structural block. All heights are with respect to present mean sea level, and ages are radiocarbon years before A.D. 1950.

preserved terraces in the study area suggest that the magnitude and frequency of uplift events in this area is small, in contrast to other tectonically active areas: e.g., the Pakarae River area (7 terraces up to 27 m a.m.s.l., Ota et al. 1983), Mahia Peninsula (6 terraces up to 13 m a.m.s.l., Berryman 1983), and south Wairarapa coast (7 terraces up to 16 m, Ota 1987).

4. T3 at Aramoana emerged at c. 3200 yr B.P. There is no correlative terrace to T3 in the Waimarama coastal plain to the north, and a c. 2300 yr B.P. terrace at Cape Kidnappers (Hull 1987) is not recognised in this study area. No correlative terrace with T2 is found at Waimarama (Fig. 6; Miyauchi et al. 1989) and Cape Kidnappers. These data suggest that the present study area lies in a different tectonic region from the Cape Kidnappers – Waimarama area.
5. Although tectonic uplift has taken place during the Holocene at Aramoana and Pourerere, it is impossible to determine the long-term rate of tectonic uplift, because no late Pleistocene marine terraces are preserved.
6. The inner part of present coast below T3 at Aramoana may represent the youngest uplift event. At Blackhead, about 0.5 km south of Aramoana, a narrow, low terrace at about 2 m high fringes the present coast. Shell fragments at Loc. 9 (Fig. 1 and Table 1) are dated at 286 ± 65 yr B.P. This terrace may be correlated with the abovementioned uplifted beach below T3.

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