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Late Quaternary tephrostratigraphy and Holocene dune development in the Papamoa-Te Puke area, Bay of Plenty

D. J. Lowe & G. N. A. Wigley*
Geochronology Research Unit and Department of Earth Sciences
University of Waikato, Private Bag 3105, Hamilton

J. Dahm
Waikato Regional Council, P.O. Box 4010, Hamilton East, Hamilton

Introduction

The Te Puke lowlands encompass the area of land seaward of Te Puke extending from Papamoa Beach in the west to Maketu Estuary in the east. The southern part of the lowlands consists of fluviatile terraces overlain by numerous late Quaternary tephra deposits (Fig. 1), the upper units providing the composite parent materials for the Allophanic Soils (Andisols) of the region (e.g. Te Puke series). The northern part comprises a belt of coastal sand dunes aligned parallel to the coast and varying in width from 100 to 1350 m. Between these units is a lowlying (2-6 m a.s.l.) area comprising drained swampland, peatland, tidal flats, river terraces, and floodplains, all formed since Holocene sea level attained its present position c. 6500 years ago (Wigley 1990).

The Holocene coastal sand dunes and peat deposits are the focus of a multidisciplinary study being coordinated by the Department of Earth Sciences, University of Waikato. The project involves determining the stratigraphy and chronology of development of the dunes using tephrochronology and radiocarbon and optical luminescence dating, the development of the soils on the dune chronosequence, and the vegetational and climatic history of the area using palynology. From these findings we hope to develop a model of dune developmental history that will ultimately help in coastal planning and management. This work forms part of a wider study of the Holocene dune systems on the western Bay of Plenty and Coromandel coasts. In addition to the authors, scientists involved in the work include Yoshitaka Nagatomo (Miyazaki University, Japan), Rewi Newnham (Otago University), Alan Hogg (Waikato University Radiocarbon Dating Laboratory), Stephen Stokes (Oxford University, England), and Paul Froggatt (Victoria University of Wellington).

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* Current address: C L Associates, Haywood House, Mucklow Hill, Halesowen, Birmingham B62 8EL, U.K.

Tephrochronology of Holocene dunes at Papamoa

Tephrochronology is a dating method based on the identification, correlation, and dating of tephra deposits. We have used this technique, together with radiocarbon dating, to obtain the chronology of development of the dunes at Papamoa Beach (Fig. 2). A similar study was undertaken on the Rangitaiki Plains by Pullar & Selby (1971). The transect, aligned perpendicular to the modern shoreline, extends inland about 1.4 km and crosses around 25 dune ridges and swales.

In many of the swales shallow peat has preserved a number of thin airfall tephra layers, as shown schematically in Fig. 2. The nearby Papamoa Bog, up to 4.5 m deep, began forming c. 4600 years ago and contains the best record of tephra fallout in the area since that time. Seven tephra deposits have been recorded (Fig. 2), all derived from either the Okataina or Taupo volcanoes. The sequence includes an enigmatic, uncorrelated rhyolitic tephra layer deposited c. 4000 years ago. The tephras were identified using stratigraphic position, field properties, ferromagnesian mineral assemblages, glass composition (by electron probe), and radiocarbon dating. Loisels Pumice was also found in several sections but has not been shown on the transect because of its uncertain reliability as a stratigraphic marker (Froggatt & Lowe 1990).

The tephrochronology indicates that the oldest dune ridge (point B on the transect) is greater than c. 4000 years old. A more specific age for the formation of this dune at just before c. 6200 years ago was obtained from radiocarbon dates on cockle shells in estuarine deposits inland from it. The dune probably marks the shoreline position c. 6500 years ago when a dune barrier rapidly evolved into a barrier estuary. The ages of the other dune ridges along the transect can be estimated by assuming that the most seaward position of each tephra layer marks the approximate shoreline position at the time of tephra emplacement. Thus, the (paleo)shoreline c. 4000 years ago was evidently about 1.1 km from the modern coast (Fig. 2). At c. 2700 years ago it was about 0.4 km inland; at c. 1800 years ago, c. 0.3 km inland; at c. 700 years ago, c. 0.1 km inland; and in AD 1886, apparently close to the modern coast. However, it is known that much of the modern foredune system was destabilised in the early 1900s (e.g. Pullar 1977) and is only now being revegetated. Consequently, it may yet eventuate that the current foredune system is older than the tephrochronology appears to indicate.

The dune system has prograded a total of about 1350 m in the past c. 6200 years, a mean rate of c. 0.2 m/year. However, the rates of progradation vary and show a marked decrease from initially rapid rates of c. 0.6 m/year from c. 4000 to c. 2700 years ago to minimal rates over the past 1000-2000 years.

The c. 6000 year-old soils on the earliest dunes are Podzol Soils (Spodosols) (e.g. Kairua series) (see also Pullar & Cowie 1967).

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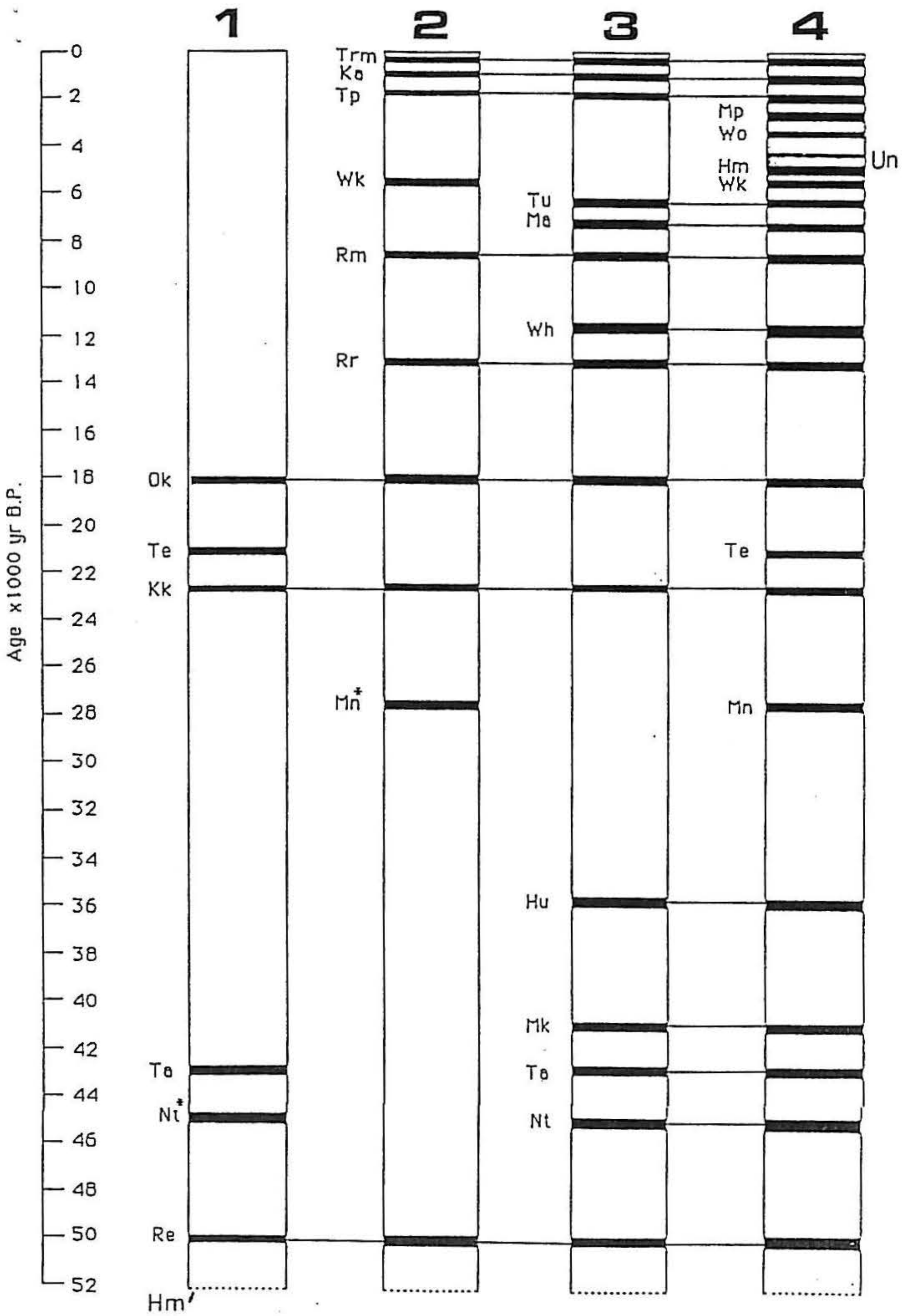
Captions to figures

Fig. 1. Generalised stratigraphic columns of late Quaternary tephra deposits in the Te Puke lowlands. Sources: 1, Vucetich & Pullar (1969); 2, Pullar & Birrell (1973); 3, Hogg & McCraw (1983); 4, Wigley (1990). Tephra abbreviations (from Froggatt & Lowe 1990) are: Trm, Rotomahana Mud (Tarawera Tephra); Ka, Kaharoa Tephra; Tp, Taupo Tephra; Mp, Mapara Tephra; Wo, Whakaipo Tephra; Un, uncorrelated; Hm, Hinemaiaia Tephra; Wk, Whakatane Tephra; Tu, Tuhua Tephra; Ma, Mamaku Tephra; Rm, Rotoma Tephra; Wh, Waiohau Tephra; Rr, Rotorua Tephra; Ok, Okareka Tephra; Te, Te Rere Tephra; Kk, Kawakawa Tephra; Mn, Mangaone Tephra; Hu, Hauparu Tephra; Mk, Maketu Tephra; Nt, Ngamotu Tephra; Re, Rotoehu Ash (Rotoiti Tephra); Hm, Hamilton Ash.
* These formations were originally referred to as Mangaoni Lapilli *bed a* (Nt) and *bed c* (Mn).

Fig. 2. Papamoa beach dune transect and associated tephrostratigraphy. Tephra abreviations as in Fig. 1. ka, conventional radiocarbon years B.P. x 1000.



1
2
3
4
Age x1000 yr B.P.
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
34
36
38
40
42
44
46
48
50
52
Trm
Ka
Tp
Wk
Rm
Rr
Ok
Te
Kk
Mn*
Tu
Ma
Wh
Hu
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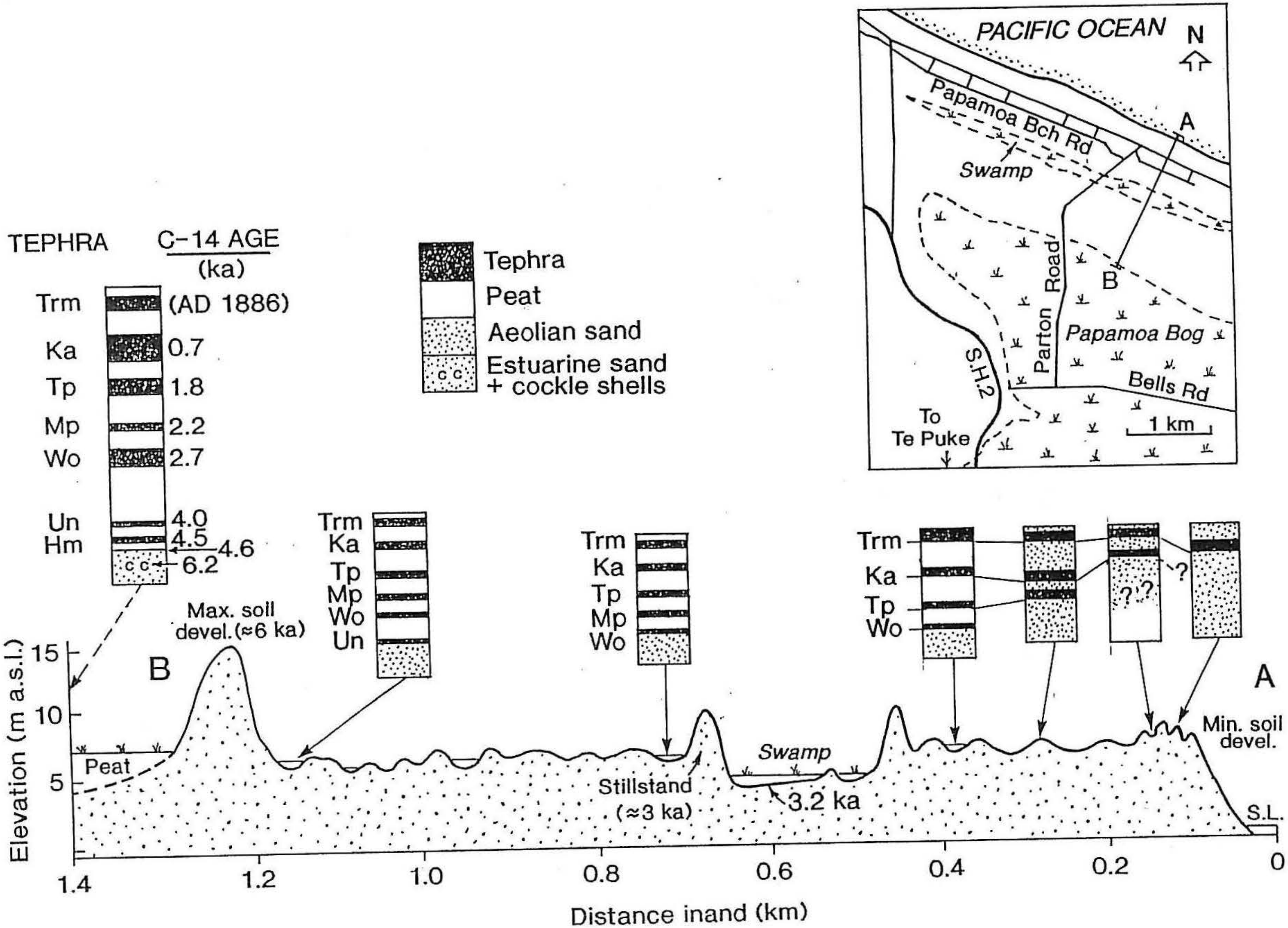
Ta
Nt
Nt*
Re
Hm'
Mp
Wo
Hm
Wk
Un
Te
Mn

Fig. 1



PACIFIC OCEAN
N
Papamoa Bch Rd
A
Swamp
B
Parton Road
Papamoa Bog
S.H.2
Bells Rd
To
Te Puke
1 km
TEPHRA
C-14 AGE (ka)
Trm
(AD 1886)
Ka
0.7
Tp
1.8
Mp
2.2
Wo
2.7
Un
4.0
Hm
4.5
4.6
6.2
Tephra
Peat
Aeolian sand
Estuarine sand + cockle shells
Max. soil devel. (≈6 ka)
Stillstand (≈3 ka)
3.2 ka
Swamp
Peat
Min. soil devel.
S.L.
Elevation (m a.s.l.)
Distance inand (km)

Fig. 2