Palynological investigations into the early Quaternary and late Tertiary vegetation and climate of west Auckland, New Zealand

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Abstract

This thesis presents a detailed late Tertiary and early Quaternary pollen record from two *c.* 40 m long sedimentary cores (the Patiki cores) from west Auckland. The cores consist of slightly to highly carbonaceous clays, with a thick sand incursion at mid-depth. The sediments below the sand incursion are aged through palynostratigraphy as mid-late Pliocene (Hautawan). The sediments above the sand incursion have numerous interbedded tephras, and are aged through a combination of Isothermal Plateau Fission Track dating, palaeomagnetism and orbital tuning to the marine oxygen isotope record as 1.0 - 1.4 Ma (MIS 28 - 45, Marahauan substage).

The Tertiary pollen record portrays regional vegetation assemblages of extinct *Nothofagus brassii*-type species and modern-day podocarps, with local modern-day oligotrophic mire assemblages. A cool climatic phase is indicated by a period of dominance of an extinct member of the Proteaceae. However, the duration of this interval cannot be determined due to a lack of numerical age control for the record.

The Quaternary pollen record consists of mostly extant pollen types. It shows multiple compositional shifts from *Nothofagus*-dominated to conifer-dominated regional vegetation, with local oligotrophic mire vegetation except for a fully aquatic phase at mid-depth (MIS 35). The primary axis score curve of a detrended correspondence analysis (DCA) of the pollen record was correlated to the marine isotope record, and shows that the *Nothofagus*-dominated intervals correspond to cool climate stages, while the conifer-dominated intervals correspond to warm stages. The strongest cool stage maximum is indicated at 12 - 13 m depth (MIS 34), where the vegetation consists of *Fuscospora*, *Prumnopitys taxifolia* and heath shrubs. The strongest warm stage maximum is indicated at c. 9 m depth (MIS 31) where the vegetation consists of *Dacrydium* forest.

Astronomically forced climate change is an important driving force behind vegetation composition changes portrayed in the Quaternary pollen record. The majority of warm stage maxima inferred in the pollen record (conifer-dominated intervals) coincide with periods of maximum obliquity, and vice versa for inferred cool stage maxima (*Nothofagus*-dominated intervals). The modulating effect of eccentricity on precession is influential on the pollen record during MIS 31 and 34. The relationship between selected climate indicator taxa and calculated insolation values indicates that reduced seasonality in Auckland during warm climate stages favours *Agathis*, *Dacrydium*, *Phyllocladus* and *Halocarpus*, while increased seasonality during cool climate stages favours *Nothofagus 'fusca'*-type, *Nothofagus menziesii*, and *Prumnopitys taxifolia*. In both situations the trees are probably responding to a combination of changes in mean global temperatures and seasonality, and reacting according to their own adaptive responses to astronomically driven climate change.

The Quaternary pollen record contains plant mixtures that do not occur in New Zealand today, for example *Agathis australis* with *Nothofagus menziesii*, and *Halocarpus bidwillii / biformis*. The climate was probably cooler than it is in Auckland today, but never as cold as the last glacial maximum in Auckland when grasslands were present. Under more equable climatic conditions, with less extreme glacial and interglacial cycles, populations of comparably 'warm' and 'cool' climate taxa were probably able to shift throughout the region and mixed to a greater extent than is currently observed. The overall vegetation response to climate change (particularly above MIS 36) is analogous to that recorded in northern New Zealand in the late Pleistocene, and supports a negligible change in climatic preference of the main canopy species since the early Quaternary. The phytosociological idiosynchracies in the pollen record are not inconsistent with the known tolerance limits of the taxa involved, or with the individualistic nature of vegetation composition.

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Ma	millions of years ago
Myr	million years
Ka	thousands of years ago
Kyr	thousand years
ODP	ocean drilling project
DSDP	deep sea drilling project
MI	marine isotope
NWMS	north west motorway section
DPS	dryland pollen sum
DCA	detrended correspondence analysis (Decorana)
ITPFT	isothermal plateau fission track aging
NZMS	New Zealand map series
LA-ICP-MS	laser ablation inductively coupled plasma mass spectrometry
GAM	generalised additive modelling

HCC	highly carbonaceous clay
SCC	slightly carbonaceous clay
NCC	non-carbonaceous clay
FAD	first appearance date
LAD	last appearance date
CVZ	Coromandel volcanic zone
TVZ	Taupo volcanic zone
MAT	mean annual rainfall
SR	solar radiation
PPT	precipitation
dB	decibels