THE NEOTECTONICS OF THE WELLINGTON AND RUAHINE FAULTS BETWEEN THE MANAWATU GORGE AND PUKETITIRI, NORTH ISLAND, NEW ZEALAND

By

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VOLUME I

Frontispiece: The Ruahine Fault from Baldy quarry (looking north) on Whittle Road, showing dextrally displaced ridges and recent eastward uplift. *Photo by Dr A S Palmer, Department Massey University.*

ABSTRACT

The Wellington and Ruahine Faults are two major faults of the North Island Dextral Fault Belt which formed approximately 2.5ma in response to the obliquely subducting Pacific Plate beneath the east coast of the North Island. Plate rotation has increased over time causing faulting patterns to change throw direction and strike-slip activity to increase within the Hawkes Bay area. Earthquakes rupturing either the Wellington or Ruahine Faults represent a serious hazard for this area.

The purpose of this study was to establish a record of paleoseismic activity on the Wellington and Ruahine Faults which would allow future estimates of likely fault behaviour to be made. Trenches were excavated across these faults in mainly swampy environments. Within these trenches are layers of earthquake debris, layers of peat and other terrestrial sediments which have been deformed by earthquake activity. The layers of peat were radiocarbon dated to give the approximate ages of underlying or overlying earthquake debris. In many areas through which the faults pass are terraces composed of gravel which has been washed down from the axial ranges composed of Torlesse greywacke. The ages of these terraces are known due to layers of dated volcanic ash preserved in cover beds and wood preserved within. Some of these terraces have been offset by the fault. Using the known age of these terraces and the distance that they are offset by the fault, it was possible to calculate rates of fault movement during late Quaternary time.

Field observations of the Wellington and Ruahine Faults reveal that the faults do not deform the areas through which they pass but rather act in response to regional deformation (within these structurally different areas). During earthquake events large blocks of land are moved both horizontally and vertically. The rate and size of these events is dependent on the regional geology where the earthquake ruptures occur. These regions are described as follows from south to north. The first region lies between Kahuki and the Ohara Depression, this is an area of prevalent strike-slip with horizontal offset rates averaging 12mm/yr for the Wellington Fault which is high by world standards. In contrast the Ruahine Fault displays little evidence of late Quaternary movement. The second region encloses the Ohara Depression which has an east-west compressional vector. Here strain is transferred from the Wellington to the Ruahine Fault thereby

lowering the horizontal offset rate for the Wellington Fault to a maximum of 4.7mm/yr. The third region lies between the Ngaruroro and Tutaekuri Rivers and is a region with a north-northeast compressional vector. Here a horizontal offset rate of 3.3mm/yr (for the Wellington Fault) was determined using offset Ohakean terrace rises. The most northern region lies between the Tutaekuri River and Napier-Taupo Highway is a zone of normal strike-slip faulting with a combined horizontal offset rate of 18mm/yr for the Wellington, Ruahine and Te Waka Faults. These regions correspond to proposed rupture segments for both Wellington and Ruahine Faults.

This study provides a record of at least 12 M_S >6.5 earthquake events recorded on the Wellington Fault in the Kahuki-Dannevirke district, 9 of which occurred in the last 30,000 years. This is the longest record of earthquake events recorded within fault trenches in New Zealand. The last earthquake on the Wellington Fault took place c. 300 years ago between Kahuki and Dannevirke. The largest single offset found in the Kahuki-Dannevirke area is estimated to have been displaced by 12m horizontally and 1.8m vertically. The estimated magnitude for an earthquake occurring in this region is between M_S 7.4 and 7.8. An earthquake of this magnitude would cause major destruction to all nearby engineering structures and to buildings in the nearby cities of Palmerston North, Napier and Hastings. Earthquakes of this size are estimated to occur every c. 300 years for the Kahuki-Dannevirke area, every 300 to 500 years for the Ohara Depression and every 1000 years for the region between the Tutaekuri River and the Napier-Taupo Highway.

Similar studies were conducted along the Ruahine Fault trace between the Ohara Depression and the Napier-Taupo Highway. Seismic activity in this area is estimated to produce a M_S 7.4 to 7.5 magnitude earthquake every 400 to 500 years. Horizontal offset is expected to be in the range of 3 to 5.5m. Dates for the last earthquake on the Ruahine Fault have not been determined but it is possible that there have been up to 4 earthquakes on this fault since 1850 yrs B.P.

The Wellington and Ruahine Faults pass mainly through farmland, areas of forestry and the southern Ruahine Range. When an earthquake rupture event occurs it is possible that most farmhouses will escape major damage with little loss of life, providing they are not built on the fault or in the path of any possible landslides. However major disruption is to be expected to any engineering works close to the faults. Landslides may occur on over-steep slopes in and near the

axial ranges and some major rivers may be dammed as a result. The larger magnitude earthquakes will produce severe shaking in the cities of Palmerston North, Napier and Hastings where substantial damage can be expected to occur, especially to those buildings that are built on reclaimed land or on alluvial soils prone to liquefaction.

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TABLE OF CONTENTS, VOLUME 1

LIST OF FIGURES :VOLUME 1

page no

LIST OF TABLES VOLUME 1

VOLUME 2, LIST OF PLATES

Plate No *Page No*

MAP POCKET CONTENTS : VOLUME 2

WELLINGTON FAULT TRENCHES

INGLIS 3 TRENCH, SCALE 1:20, *South wall*
INGLIS 4 TRENCH, SCALE 1:20, *North wall*
BEAGLEY ROAD TRENCH, SCALE 1;20, *West wall*
TROTTER 1 TRENCH, SCALE 1:20, *North, south and east walls plus correlated sequence of events for Trotter 1 and 2 trenches*
TROTTER 2 TRENCH, SCALE 1:20, *North, south, east and west walls*
MC COOL 1 TRENCH, SCALE 1:20, *North and south walls*
MC COOL 2 TRENCH, SCALE 1:40, *East Wall*
MC COOL 3 TRENCH, SCALE 1:20, *North, east and south walls*
SYME TRENCH, SCALE 1:20, *North wall*

TE WAKA SPLINTER FAULT TRENCH

WEDD TRENCH, SCALE 1:20, *South wall*

RUAHINE FAULT TRENCHES

DAVIS 1 TRENCH, SCALE 1:20, *North wall*
DAVIS 2 TRENCH, SCALE 1:20, *North and south walls*