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

By

Judith Ann Hanson

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Doctor of Philosophy in Earth Science**

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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

Title page.....	i
Frontispiece.....	ii
Abstract.....	iii
Acknowledgments.....	iv
CHAPTER 1 INTRODUCTION.....	1
CHAPTER 2 REGIONAL GEOLOGY.....	9
CHAPTER 3 THE WELLINGTON FAULT BETWEEN THE MANAWATU GORGE AND KUMETI ROAD.....	20
<i>Inglis Farm Trenches.....</i>	<i>22</i>
<i>Trenching on Beagley Farm.....</i>	<i>41</i>
<i>The Paper Road Site.....</i>	<i>45</i>
<i>Trotter Farm Trenches.....</i>	<i>47</i>
<i>Summary of Paleoseismic data for the Wellington Fault between the Manawatu Gorge and Kumeti Road.....</i>	<i>62</i>
CHAPTER 4 THE WELLINGTON FAULT FROM KUMETI ROAD TO THE NGARURORO RIVER.....	65
<i>Trenching on McCool Farm.....</i>	<i>71</i>
<i>Discussion and Proposed Offset Rates for the Ohara Depression.....</i>	<i>81</i>
CHAPTER 5 THE WELLINGTON FAULT FROM THE NGARURORO RIVER THROUGH THE PUKETITIRI AREA TO THE NAPIER- TAUPO HIGHWAY.....	83
<i>Trenching on Hawkstone Station.....</i>	<i>87</i>
<i>Discussion of offset rates for the Hawkstone area of the Wellington Fault.....</i>	<i>91</i>
<i>The Te Waka Splinter Fault.....</i>	<i>92</i>
<i>Trenching on Wedd Farm.....</i>	<i>93</i>
<i>Offset rates for the Wellington and Te Waka Faults.....</i>	<i>98</i>
CHAPTER 6 THE RUAHINE FAULT FROM THE MANAWATU GORGE TO THE KAWEKA FOREST.....	100
CHAPTER 7 THE RUAHINE FAULT BETWEEN THE KAWEKA FOREST AND THE NAPIER-TAUPO HIGHWAY.....	108
<i>Trenching on Davis Farm.....</i>	<i>108</i>
<i>Summary of recent offset features and offset rates for the Ruahine Fault.....</i>	<i>122</i>

CHAPTER 8 SUMMARY OF PALEOSEISMIC DATA FOUND IN EXCAVATED TRENCHES AND ALONG FAULT TRACES.....	124
<i>Common Structural features indicative of faulting events and sedimentation rates seen in the excavated trenches.....</i>	<i>124</i>
<i>Fault scarp morphology.....</i>	<i>127</i>
CHAPTER 9 PALEOSEISMIC HAZARDS FOR THE WELLINGTON AND RUAHINE FAULTS.....	131
<i>Fault structure, segmentation and surface rupture.....</i>	<i>131</i>
<i>Earthquake magnitude and intensity models.....</i>	<i>137</i>
<i>Summary of timing and earthquake events for the Wellington and Ruahine Faults.....</i>	<i>140</i>
<i>Ground shaking and landslides.....</i>	<i>142</i>
CHAPTER 10 DISCUSSIONS AND CONCLUSIONS.....	147
<i>Subduction zone tectonics and predictions for future earthquake events.....</i>	<i>147</i>
<i>Horizontal offset rates and the history of strike-slip faulting for the Wellington and Ruahine faults.....</i>	<i>153</i>
<i>Summary of paleoseismic activity for the Wellington and Ruahine Faults.....</i>	<i>155</i>
<i>Future work.....</i>	<i>156</i>
Appendix 1, Seddigraph and XRD analysis of Tertiary Mudstone, Unctuous Clay and Unknown Shelf Material.....	160
Appendix 2, Tephra Descriptions and ages.....	162
Appendix 3, Descriptions and ages of Ohakean, Ratan and Porewan River Terraces.....	164
Appendix 4, Modified Mercalli Scale and associated hazards.....	166
Appendix 5, Summary of Radiocarbon and AMS dates.....	168
References.....	169

LIST OF FIGURES :VOLUME 1

	<i>page no</i>
FIGURE 1 Field Area Locality.....	8
FIGURE 2 The Ohara Depression.....	14
FIGURE 3 Locality Map from NZMS SHEET 24.....	21
FIGURE 4 Wellington Fault and Trench location on Inglis Farm.....	23
FIGURE 5 Inglis 3 trench.....	26
FIGURE 6 Inglis 4 trench.....	28
FIGURE 7 Duplex models.....	30
FIGURE 8 Sequence of events Inglis 3 trench.....	32
FIGURE 9 Sequence of events Inglis 4 trench.....	36
FIGURE 10 Surface faulting events, Inglis Farm.....	38
FIGURE 11 Displacements, Inglis Farm.....	39
FIGURE 12 Offset Streams, Beagley Farm.....	42
FIGURE 13 Beagley Farm trench.....	43
FIGURE 14 Locality Map NZMS T23.....	46
FIGURE 14A Paper Road site.....	47
FIGURE 15 Trotter 1 trench.....	52
FIGURE 16 Trotter 2 trench, north wall.....	53
FIGURE 17 Trotter 2 trench, south wall.....	54
FIGURE 18 Duplex at Fairbrother Road.....	60
FIGURE 19 Duplex, sequence of events.....	61
FIGURE 20 Kashmir to Alder roads NZMS U22.....	66
FIGURE 21 Southern Ohara Depression NZMS U22.....	69
FIGURE 22 Northern Ohara Depression NZMS U21.....	70
FIGURE 23 McCool 1 trench north wall.....	73
FIGURE 24 McCool 1 trench south wall.....	74
FIGURE 25 McCool 3 trench north wall.....	77
FIGURE 26 The Wellington and Ruahine Faults, NZMS U21.....	84
FIGURE 27 Offset Ohakean terraces, north bank Ngaruroro River.....	85
FIGURE 28 Wellington and Te Waka Splinter Faults.....	86
FIGURE 29 Syme trench Hawkstone Station.....	89
FIGURE 30 Wedd trench, Te Waka Splinter Fault.....	96
FIGURE 31 Ruahine Fault NZMS U22.....	102
FIGURE 31a Ruahine Fault NZMS U20.....	105
FIGURE 32 Ruahine Fault NZMS U20+V20.....	110
FIGURE 33 Ruahine Fault NZMS V20.....	111
FIGURE 34 Davis 1 trench north wall.....	114
FIGURE 35 Davis 1 trench south wall.....	115
FIGURE 36 Davis 2 trench north wall.....	116
FIGURE 37 Davis 2 trench south wall.....	117
FIGURE 38 Fault Scarp Morphology.....	128
FIGURE 39 Cartoon of eastward uplift.....	151

LIST OF TABLES VOLUME 1

<i>Wellington Fault</i>	<i>page</i>
Table 1, Summary of paleoseismic events.....	63
Table 2, Vertical offset rates; Manawatu Gorge to Kumeti Road.....	63
Table 3, Horizontal offset rates, Manawatu Gorge to Kumeti Road.....	64
<i>Ruahine fault</i>	
Table 4, Faulting events for Davis 1 and 2 trenches.....	123
Table 5, Summary of paleoseismic events for the Kahuki-Dannevirke segment of the Wellington Fault.....	141
Table 6, Summary of events for the Ohara Depression of the Wellington Fault..	141
Table 7, Summary of events for the Tutaekuri to Napier-Taupo Highway segment of the Wellington Fault.....	141
Table 8, Summary of events for the Tutaekuri-Napier-Taupo Highway segment of the Ruahine Fault.....	142
Table 9, Cities and Towns in close proximity to the Wellington and Ruahine Faults.....	143
Table 10, Summary of timing for eastward uplift.....	152
Table 11, Horizontal and vertical offset, Wellington Fault.....	154
Table 12, Horizontal and vertical offset, Ruahine Fault.....	154
Table 13, Paleoseismic activity, Wellington Fault.....	156
Table 14, Paleoseismic activity, Ruahine Fault.....	156

VOLUME 2, LIST OF PLATES

<i>Plate No</i>	<i>Page No</i>
1, The Wellington and Ruahine Faults south of the Manawatu Gorge.....	1
2, Engineering structures in the Manawatu Gorge.....	2
3, Steeply dipping Nukumaruan Limestone.....	2
4, Aerial photograph of the Manawatu Gorge and Limestone.....	3
5, Aerial photograph of the Nukumaruan Limestone Block.....	4
6, Slump feature in limestone.....	5
7, Silty unit underlying the limestone.....	5
8, Limestone/silty unit contact.....	6
9, Wellington fault duplex at Inglis' Farm.....	7
10, Main fault plane Inglis 3 trench.....	8
11, Horizontal fault Inglis 3 trench.....	9
12, Mini graben northeast trench wall, Inglis 3 trench.....	10
13, Mini graben south trench wall, Inglis 3 trench.....	11
14, Drag structures in unctuous clay unit (Inglis 3 trench).....	12
15, Inglis 4 trench north wall.....	13
16, Inglis 4 southwest trench wall.....	14
17, Inglis 4 horse in south trench wall.....	15
18, Inglis 4 footwall horse.....	16
19, Wellington Fault at Beagley Road.....	17
20, Fault scarp at Beagley Road.....	18
21, Beagley trench.....	18
22, Offset streams at Beagley Road (aerial view).....	19
23, Paper Road, Wellington Fault.....	20
24, Offset stream at Coppermine Road.....	21
25, Fault scarp at Trotter 2.....	21
26, Duplex at Fairbrother Road.....	22
27, Trotter 1 trench.....	23
28, Offset stream (Trotter Farm).....	23
29, Trotter 2 trench south wall.....	24
30, Trotter 2 trench north wall.....	24
30a, Offset ridges just north of Apiti Saddle.....	25
31, Wellington Fault, offset spurs at Moorcock Stream.....	26
32, Wellington Fault scarp at Gull Road.....	27
33, Pipe repairs at Gull Road (evidence of fault creep ?).....	27
34, McCool 1 trench north wall.....	28
35, McCool 1 trench south wall.....	28
36, Wellington Fault scarp at Big Hill.....	29
37, McCool 3 trench site.....	29
38, Offset overflow streams McCool Farm.....	30

39, McCool 3 trench, north wall.....	31
40, Wellington Fault scarps, south bank Ngaruroro River.....	32
41, Offset Ohakean Terraces north bank Ngaruroro River.....	33
42, Fault scarps crossing Ohakean terraces.....	33
43, Wellington Fault crossing Hawkstone Station.....	34
44, Wellington Fault, eastern edge Maniaroa Range.....	34
45, Syme trench Hawkstone Station.....	35
46, Wellington Fault, Potter Road.....	36
47, Wellington Fault north of the Napier-Taupo Highway.....	36
48, Wellington and Te Waka Splinter Faults south of Puketitiri Road.....	37
49, Te Waka Splinter Fault.....	38
50, Small scarps, Te Waka Splinter Fault.....	38
51, Wedd trench, Te Waka Splinter Fault.....	39
52, U-shaped valley, Te Waka Splinter Fault.....	40
53, Te Waka and Titiokura Limestone.....	40
54, Offset Te Waka Limestone.....	41
55, Te Waka Splinter Fault, termination splays.....	42
56, Ruahine Fault between North Block and Glenny Roads.....	43
57, Ruahine Fault north of Whittle Road.....	44
58, Davis 1 trench, Ruahine Fault.....	45
59, Davis 1 trench, Ruahine Fault.....	46
60, Ruahine Fault south of Whittle Road.....	47
61, Davis 2 trench, Ruahine Fault.....	48
62, Ruahine Fault, Kaweka Range.....	49
63, Ruahine Fault? Hot Springs Road.....	50
63, Ruahine Fault, south of the Mohaka-Ripia junction.....	51
64, Nukumaruan Limestone, Napier-Taupo Highway.....	52

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*