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GEOLOGY AND ITS RELATIONSHIP TO EROSION
IN THE SOUTHERN RUAHINE RANGE,
NORTH ISLAND, NEW ZEALAND

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for the degree of Doctor of Philosophy in Soil Science
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ABSTRACT

The structure and lithology of a sequence of Mesozoic greywackes comprising the Torlesse terrane within the southern Ruahine Range has been mapped. At a scale of 1:25 000 the sequence was subdivided into informal lithozones with one or more lithozones constituting a higher order lithostratigraphic unit here referred to as a Lithotype. Each of three recognised Lithotypes occupies a consistent stratigraphic position throughout a 40 km long mapped area. From east to west the three Lithotypes are: (1) the Tamaki Lithotype; (2) the Wharite Lithotype; and (3) the Western Lithotype. The easternmost Tamaki Lithotype and the westernmost Western Lithotype consist of a relatively undeformed flysch-type sequence of distal turbidites. The centrally located Wharite Lithotype structurally underlies the Tamaki Lithotype but overlies the Western Lithotype. It comprises a complex sequence of predominantly flysch-type sedimentary rocks, together with lithologically diverse, argillite-dominated, clast-bearing debris flow deposits; large sheet-like bodies of massive volcanics (and associated cherts) that have been emplaced by gravitational sliding; and intact pillow lava accumulations and horizons of red and green argillite of syndepositional origin.

Major and trace element analyses of volcanic lithologies indicate that most samples were erupted in a mid-ocean ridge or intraplate setting. None appear to have been derived from an island arc setting.

The bulk of the clastic sediments consist of reworked materials derived by the erosion of a mixed volcano-plutonic source and redeposited in a distal deep-water submarine fan environment. Blocks of allochthonous fossiliferous shallow-water lithologies indicate that the source terrane, in part, comprised rocks of Late Triassic age. Autochthonous fossils indicate that sedimentation continued until at least Late Jurassic time.

Part of the stratigraphic sequence was severely deformed along a low angle thrust zone in Early Cretaceous time at the onset of the Rangitata Orogeny. An early phase of ductile deformation resulted in plastically and permanently deformed rocks. Ductile deformation is restricted to strata comprising the Wharite Lithotype which, with its allochthonous debris, in part, constitutes an olistostrome that has undergone tectonic deformation and hence also constitutes a melange. Thus it may be regarded as a tectonised olistostrome. Ductile deformation was succeeded by the development of shear fractures during subsequent phases of brittle deformation that affected strata comprising all three Lithotypes. Brittle deformation

occurred in conjunction with episodes of faulting and folding during the second orogeny - the Kaikoura Orogeny in Pliocene to Recent times.

Active faults that were initiated during the early phase of ductile deformation continued to be sites of active fault displacement throughout Quaternary and Holocene time. Late Quaternary tectonic features along these major active faults have been mapped. Minimum rates of vertical fault displacements since Ohakean time approximate 1 mm/yr in this area.

Several phases of folding were recognised, including: (1) an early phase of syndepositional, highly asymmetric folds with well developed axial plane cleavage; and (2) three post-lithification phases of folding - e.g. (a) steeply plunging isoclinal folds; (b) subhorizontal, open asymmetric folds; and (c) steeply plunging open folds.

Contacts between the three Lithotypes are not thought to be major tectonic breaks but are instead of primary depositional origin and have become sites of subsequent fault movement in Quaternary time. The three Lithotypes may therefore represent a near complete eastward dipping, westward younging overturned stratigraphic sequence. They are not fault-bound terranes.

Metamorphism to prehnite pumpellyite grade, folding and rotation of the strata to its present steep attitude predates Late Cretaceous sedimentation. The westward rotation and imbrication of thrust sheets that are internally westward younging but form part of a regionally eastward younging succession of thrust sheets was the result of underthrusting at a convergent plate margin.

The relationship between structural and lithological characteristics of the Torlesse bedrock and the magnitude of valley slope erosion in the southern Ruahine Range is investigated. Comparison of aerial photographs spanning a 28 year period between 1946 and 1974 indicate that erosion has increased by 91%. The greatest proportion of this eroded area occurs on the steeper north- and west-facing slopes. Saturation of colluvium during major storm events is the prime triggering mechanism for the majority of shallow translational slope movements. Debris slides and debris avalanches predominate and result from failure at less than 1m depth at the colluvium-bedrock contact. Rock slides are few in number and are structurally controlled, failing along bedding plane surfaces at greater than 1m depth. Rock falls and rock topples are least numerous and only involve small quantities of material.

An erosion rate of $1215\text{m}^3/\text{ha}/\text{yr}$ for the southern Ruahine Range is of the same order of magnitude as other New Zealand and overseas studies and although considered to be severe it is not unduly excessive.

Much of the forest deterioration in this area is due to the opening of the canopy by the successive removal of large tracts of forest vegetation through mass movement processes during episodes of increased rainfall.

Large-scale rotational and translational mass movement features including rock slumps, earth slumps, earth slides and ridge-top features (involving bedrock only), have been documented from 109 localities. A relationship between the incidence of rock slumps and major fault breccia zones has been established in this area. The majority of large-scale mass movement features failed in pre-historic time but two failed in historic time. The consequences of future mass movements upon lowland areas adjacent to the base of the Range is discussed.

A map showing the relative stability of slopes and the predominant forms of slope movement most likely to occur under the present seismic, climatic, physiographic and human conditions is presented.

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T A B L E O F C O N T E N T S

(details of contents precede each chapter)

	<u>page</u>
ABSTRACT 	ii
ACKNOWLEDGEMENTS	v
TABLE OF CONTENTS 	vii
LIST OF FIGURES	viii
LIST OF TABLES	xv
LIST OF MAPS 	xvii
LIST OF APPENDICES 	xviii

PART ONE : GEOLOGY OF THE SOUTHERN RUAHINE RANGE

CHAPTER 1: Introduction	1
CHAPTER 2: Stratigraphy and Lithology	21
CHAPTER 3: Sedimentary Structures and Palaeoenvironmental Analyses	76
CHAPTER 4: Palaeontology	106
CHAPTER 5: Petrography	117
CHAPTER 6: Late Quaternary Tectonics 	142
CHAPTER 7: Structure and Deformation 	190
CHAPTER 8: Geological History	221
POTENTIAL RESEARCH 	235

PART TWO : RELATIONSHIPS BETWEEN GEOLOGY AND EROSION - SOUTHERN RUAHINE RANGE

INTRODUCTION 	237
CHAPTER 9: Slope Movement Types and Processes 	238
CHAPTER 10: Factors that Influence Slope Stability	251
CHAPTER 11: Late Quaternary Erosion Events 	340
CHAPTER 12: Past, Present and Potential Patterns of Slope Stability 	348
REFERENCES	386
APPENDICES	A1

LIST OF FIGURES

	<u>page</u>
FIGURE 1.1: Map showing position of study area in relation to the axial ranges of the North Island	5
FIGURE 1.2: Southern Ruahine Range - location map	6
FIGURE 2.1: A tectonic-stratigraphic subdivision of New Zealand, compiled after Landis & Bishop (1972), Speden (1975) and Coombs <i>et al.</i> (1976)	22
FIGURE 2.2: Distribution of Torlesse bedrock and Plio-Pleistocene marine deposits, southern Ruahine Range	27
FIGURE 2.3: Small sized conglomerate pebbles within a fine- to medium-grained sandstone matrix	33
FIGURE 2.4: Coarser sized pebbles than in Figure 2.3 set within a medium-grained sandstone matrix	33
FIGURE 2.5: Lenses of calcareous siltstone (arrowed) within an interbedded sequence of sandstone, siltstone and argillite comprising the Tamaki Lithotype	35
FIGURE 2.6: Strata comprising Very Thin-Bedded Association of the Tamaki Lithotype exposed on Delaware Ridge at locality T23/664174	38
FIGURE 2.7: A representative example of the Thin-Bedded Association of the Tamaki Lithotype in Rokaiwhana Stream at locality T23/664157	38
FIGURE 2.8: Schematic diagram showing field relationships between mappable lithozones within Wharite Lithotype	43
FIGURE 2.9: Pebble-dominated conglomerate containing predominantly clastic and volcanic lithologies set within a sandstone matrix	47
FIGURE 2.10: Pebble-dominated conglomerate containing clastic and volcanic lithologies set within a muddy siltstone matrix	47
FIGURE 2.11: Conglomerate comprising predominantly muddy siltstone matrix within which pebbles of clastic and volcanic lithologies are randomly scattered	48

FIGURE 2.12:	Conglomerate consisting of rounded to subangular, light coloured, fine-coarse grained sandstone and siltstone pebbles set within a darker sandy matrix	48
FIGURE 2.13:	An autoclastic breccia comprising angular chips of sandstone with signs of internal quartz veining, set within an argillaceous matrix	50
FIGURE 2.14:	An autoclastic breccia consisting of stretched and attenuated thin beds of sandstone interbedded with argillite	50
FIGURE 2.15:	A slabbed sample of ?diorite containing large feldspar phenocrysts set within a dark fine-grained mafic matrix	52
FIGURE 2.16:	A slabbed sample of vesicular basalt containing amygdules of calcite	52
FIGURE 2.17:	Interbedded red and green argillites together with clasts of spilite (sp), chert (ct) and sandstone (sd), lithologies	53
FIGURE 2.18:	A variety of coloured chert lithologies found as thin discontinuous lenses within Foliated Lithozones or as discrete clasts within Diamictite Lithozones	55
FIGURE 2.19:	A clast of laminated, blue-green chert	55
FIGURE 2.20:	Sample of copper ore from Maharashtra Coppermine within Coppermine catchment, showing green efflorescence of copper carbonate (Malachite) ...	57
FIGURE 2.21:	Chert breccia, consisting of angular coloured chips of chert set in a microcrystalline siliceous cement, was found in Makohine catchment at locality T23/498050	58
FIGURE 2.22:	Autoclastic chert breccia comprising angular, white coloured chips of chert set within an indurated argillaceous matrix	58
FIGURE 2.23:	Calcareous conglomerate containing rounded pebbles with brown weathered exterior set in a calcareous sandstone matrix	60
FIGURE 2.24:	Foliated Lithozone within which once-bedded sandstone units have been pulled apart along strike, during deformation, into isolated lenses	66

FIGURE 2.25:	Diamictite which contains very angular chert clasts of small size range within a sheared argillaceous matrix	68
FIGURE 2.26:	Diamictite containing clasts of varying sizes and compositions, within a sheared argillaceous matrix	68
FIGURE 2.27:	An outcrop of argillite that is essentially devoid of clasts and interbeds of competent lithologies and has been mapped as an Argillite Lithozone ..	73
FIGURE 3.1:	Ideal sequence of structures in a turbidite bed (the Bouma sequence), from Bouma (1962) and Blatt <i>et al.</i> (1972)	78
FIGURE 3.2:	Three upward grading $T_{a'e}$ units consisting of a basal siltstone and an upper argillite	79
FIGURE 3.3:	Slabbed rock sample of <i>in situ</i> siltstone containing wisps of argillite. The siltstone grades westward into an overlying bed of argillite	81
FIGURE 3.4:	Thin parallel laminations of alternating argillite (dark layers) and fine-grained siltstone (light layers)	82
FIGURE 3.5:	A variety of internal sedimentary structures including disrupted beds, load structure, argillite wisps and truncated cross-lamination	86
FIGURE 3.6:	Disrupted siltstone horizons interbedded within an argillaceous medium. The lenses of argillaceous material within the siltstone horizons are possibly injection structures as a result of syndepositional deformation	86
FIGURE 4.1:	Specimens of <i>Retroceramus</i> (<i>Retroceramus</i>) <i>haasti</i> (Hochstetter) (T23/f3) found within Rokaiwhana catchment at T23/644142	109
FIGURE 4.2:	Fossiliferous calcareous conglomerate containing fragments of foraminifera and ?bryozoa	111
FIGURE 4.3:	Radiolarian chert showing radiolaria with double ring structure	111
FIGURE 5.1:	SiO_2 variation diagram for volcanic samples from the southern Ruahine Range	131

FIGURE 5.2:	Zr variation diagram for volcanic samples from the southern Ruahine Range	132
FIGURE 5.3:	Ti-Zr-y discriminant plot	134
FIGURE 5.4:	Zr/y-Zr discriminant plot	134
FIGURE 5.5:	Ti-V plot of volcanic samples from the southern Ruahine Range	135
FIGURE 6.1:	Reference map of the mapped region showing map-sheet boundaries, major faults and faulted monocline	143
FIGURE 6.2:	Dextral transcurrent displacement of high level terrace surface of ?Porewan age on Wellington Fault trace	152
FIGURE 6.3:	Cross-section at Ballantrae Research Station showing stratigraphy of localities from which radiocarbon dated samples of wood were collected, in relation to the trace of Wellington Fault . . .	157
FIGURE 6.4:	Stereoscopic pair showing a tilted wedge located at T24A/477899 on the trace of Wellington Fault . . .	163
FIGURE 6.5:	Diagrammatic sketch illustrating features of tectonic origin commonly found along active fault traces	181
FIGURE 7.1:	Small-scale hinge zone of a steeply plunging isoclinal fold in Wharite Lithotype	193
FIGURE 7.2:	Rose diagrams showing orientation of fold axes, faults and joints	194
FIGURE 7.3:	Subhorizontal, open flexure involving eastward-dipping, thin-bedded strata comprising Tamaki Lithotype	195
FIGURE 7.4:	Subhorizontal, near isoclinal fold comprising thin-bedded strata of the Tamaki Lithotype . . .	195
FIGURE 7.5:	Carbonate-cemented fault breccia (white colour) within a 30m wide fault zone	199
FIGURE 7.6:	Thin beds showing slight thickness variations due to soft-sediment extension of competent sandstone beds and ductile behaviour of argillite beds . . .	201

FIGURE 7.7:	Extremely disrupted and mixed clasts of sandstone encompassed by argillaceous matrix	202
FIGURE 7.8:	Extensional shear fractures within lensed clasts of sandstone	205
FIGURE 7.9:	Post-metamorphic, non-mineralised shear surfaces with partings up to 0.01m width across the fracture	208
FIGURE 8.1:	Structural contour map of marine erosion surface preserved in the southern Ruahine and northern Tararua Ranges	230
FIGURE 9.1	Debris avalanche resulting from failure within bedrock	241
FIGURE 9.2:	Debris avalanche scars on steep valley slopes within Mangapuaka catchment	241
FIGURE 9.3:	A schematic block diagram showing the characteristic features of a typical slump in the southern Ruahine Range	248
FIGURE 10.1:	Extensive debris slide development within South Oruakeretaki catchment	256
FIGURE 10.2:	Close-up of debris slide scar within Mangapuaka catchment	256
FIGURE 10.3:	Torlesse bedrock overlain and in sharp contact with peaty loam	257
FIGURE 10.4:	Variations in the structural attitude of strata with respect to slope angle and direction, that largely determine the type of slope failure likely to occur in catchments underlain by the Tamaki Lithotype	258
FIGURE 10.5:	Variations in the structural attitude of foliated bedrock with respect to slope angle and direction, that largely determine the type of slope failure likely to occur in catchments underlain by the Wharite Lithotype	259
FIGURE 10.6:	A rock slide resulting from downslope movement along a bedding plane surface within bedrock comprising the Tamaki Lithotype	261

FIGURE 10.7:	An undisrupted rock slide resulting from downslope movement along a lithological contact within bedrock comprising the Wharite Lithotype	261
FIGURE 10.8:	Very shallow debris avalanches resulting from failure at the colluvium-bedrock contact	265
FIGURE 10.9:	Stereoscopic view of large-scale earth movements in the lower reaches of No. 1 Line and No. 2 Line Streams	267
FIGURE 10.10:	Schematic diagram illustrating variations in the structural attitude of joint surfaces, with respect to the free face of sandstone bluff, along which failure results in rock fall activity	268
FIGURE 10.11:	Rock fall resulting from failure along the north-south trending joint system	270
FIGURE 10.12:	Position of Wellington Fault trace in relation to rock slump at locality 36	274
FIGURE 10.13:	Position of Wellington Fault in relation to rock slump at locality 30	276
FIGURE 10.14:	Position of Wellington Fault trace in relation to rock slump at locality 11	277
FIGURE 10.15:	Position of Ruahine Fault trace in relation to rock slump at locality 61	279
FIGURE 10.16:	Position of Piripiri Fault trace in relation to rock slump at locality 2	281
FIGURE 10.17:	Large-scale rock slump with well defined lateral and headwall scarps	283
FIGURE 10.18:	Small-scale rock slumps and debris slides involving disrupted bedrock lithologies of the Wharite Lithotype and thick accumulations of colluvium	283
FIGURE 10.19:	Stereoscopic photo-pair of large-scale earth slump at locality 108	286
FIGURE 10.20:	Frequency and magnitude of flood events recorded in the upper Manawatu River catchment	309
FIGURE 10.21:	Rilling within colluvium at the head of a debris slide scar	313

FIGURE 10.22:	A typical example of structurally controlled gully erosion within strata comprising the Tamaki Lithotype	316
FIGURE 10.23:	An example of gully erosion within bedrock strata comprising the Wharite Lithotype	316
FIGURE 11.1	Whiteywood Creek fan deposit in which at least three levels of gravel aggradation are recorded	342

L I S T O F T A B L E S

page

TABLE 2.1:	Strata of the Tamaki Lithotype comprise a Graded-Bedded Lithozone. This Lithozone is subdivided into Associations on the basis of average outcrop thickness of individual beds	36
TABLE 2.2:	Strata of the Wharite Lithotype are differentiated into seven distinct Lithozones. The Graded-Bedded Lithozone is further subdivided into Associations on the basis of average outcrop thickness of individual beds	62
TABLE 2.3:	Diagnostic features at outcrop scale of three major Lithozones comprising the Wharite Lithotype . . .	64
TABLE 2.4	Strata of the Western Lithotype comprise a Graded-Bedded Lithozone. This Lithozone is subdivided into Associations on the basis of average outcrop thickness of individual beds	74
TABLE 4.1:	Fossil record dates from study area	107
TABLE 6.1:	Upper Quaternary stratigraphy of the Upper Manawatu district immediately to the east of the southern Ruahine Range between Woodville and Ruaroa .. .	155
TABLE 9.1:	Classification of slope movements in the southern Ruahine Range (after Varnes, 1978)	238
TABLE 10.1:	Percentage and type of shallow translational slope movement in the southern Ruahine Range resulting from failure at varying depths	257
TABLE 10.2:	Distribution of erosion scars with respect to altitude	299
TABLE 10.3:	Distribution of erosion scars with respect to aspect	300
TABLE 10.4a:	Results of measurement of slope gradient, determined from unpublished 1:25 000 topographic maps, within the study area	303
TABLE 10.4b:	Measurements of slope gradient with respect to aspect	303
TABLE 11.1:	Periods of erosion in the southern Ruahine Range and West Tamaki Basin	340

TABLE 12.1:	Calculation and comparison of the area in actively eroding slips within upper catchments along the western flank of the southern Ruahine Range . . .	350
TABLE 12.2:	Calculation and comparison of the area in actively eroding slips within upper catchments along the eastern flank of the southern Ruahine Range . . .	351
TABLE 12.3:	Calculation of annual erosion rates 1946-74 . . .	357
TABLE 12.4:	Annual erosion rates, 1946-74, southern Ruahine Range	359
TABLE 12.5:	Annual erosion and sediment transport rates, New Zealand and overseas	359
TABLE 12.6:	Estimated volumes of material contained in large-scale, deep-seated mass movements	368

L I S T O F M A P S

(contained in map pocket in Volume III)

- MAP ONE: Lithological Outcrop Map of the Southern Ruahine Range.
- MAP TWO: Field Observation Map of the Southern Ruahine Range.
- MAP THREE: Structural Interpretation Map of the Southern Ruahine
Range.
- MAP FOUR: Late Quaternary Tectonic Map of the Southern Ruahine
Range.
- MAP FIVE: Distribution of Surficial Erosion Scars and Mass Movement
Features - Southern Ruahine Range in the Years 1946 to
1949.
- MAP SIX: Distribution of Surficial Erosion Scars and Mass Movement
Features - Southern Ruahine Range in the Years 1974 to
1978.
- MAP SEVEN: Map of Relative Slope Stability, Southern Ruahine Range.

LIST OF APPENDICES

page

APPENDIX Ia:	Manawatu Catchment Board expenditure on erosion control and investigations into the erosion problem along the southeastern Ruahine Range front	A1
APPENDIX Ib:	Estimated government subsidies (on a basis of 3:1) required by the Board during the next five year period	A1
APPENDIX IIa:	Forest Service expenditure on slope and streambed stabilisation in the southern Ruahine Range ...	A1
APPENDIX IIb:	Estimated future expenditure by the Forest Service on slope and streambed stabilisation	A1
APPENDIX IIIa:	Faunal list for limestone block T23/f7530	A2
APPENDIX IIIb:	Comments on the identification, interpretation and significance of the faunal content of T23/f7530 (extracts from unpublished manuscript and/or pers coms)	A3
APPENDIX IIIc:	Conodont fauna from fossiliferous limestone block T23/f7530	A6
APPENDIX IVa:	Abbreviations used to denote locality of rock samples and corresponding petrological slides	A7
APPENDIX IVb:	Rock sample and petrological slide localities	A8
APPENDIX IVc:	Major and trace element analyses of spilitic rocks from the southern Ruahine Range	A9
APPENDIX Va:	Late Quaternary Tectonic Data	A11
APPENDIX Vb:	Radiocarbon dates collected from study area ...	A25
APPENDIX VI:	Changes in the state of activity of major mass movement features in the southern Ruahine Range between the years 1946 to 1949 and 1974 to 1978	A26
APPENDIX VII:	Reference numbers of rock samples in the Massey University Reference Collection sampled from the southern Ruahine Range	A42

PART ONE

GEOLOGY OF THE SOUTHERN RUAHINE RANGE
