SOME ASPECTS OF THE CENOZOIC GEOLOGY OF THE MOAWHANGO RIVER REGION, IN THE ARMY TRAINING AREA, WAIOURU, NORTH ISLAND, NEW ZEALAND.

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ABSTRACT

Late Tertiary marine strata of the Waiouru Formation were unconformably deposited on a dissected Late Cretaceous peneplain surface of unusually high relief formed on Torlesse Supergroup greywacke at Waiouru, Central North Island, New Zealand. Waiouru is uniquely located on the southern boundary of the Taupo Volcanic Zone and the northern margin of the Wanganui Basin, an infilled Pliocene basin now subject to Plio-Pleistocene uplift.

Two transgressive episodes are identified. The first involved submergence of the peneplain in the Neogene, when Kapitean mudstone was deposited. Then a general marine shallowing occurred around the New Zealand landmass which saw uplift of Waiouru towards the end of the Kapitean Stage, followed by a period of sub-aerial erosion. The second transgressive episode was initiated by subsidence of the Wanganui Basin in the Pliocene, which led to onlap of coarse shallow-water sandstones during the Opoitian Stage.

Basement subsidence tended to result in vertical rather than horizontal migration of the shoreline. No evidence has been found for previously recognised eustatic sealevel cycles, due possibly to masking by strong tidal conditions throughout the Opoitian sequence; Waiouru being located on the northern edge of the Pliocene Kuripapango Strait. Eventually, shallow seas supported a faunal population sufficient to produce widespread carbonate skeletal fragments that formed extensive shell limestone beds at the top of the Waiouru Formation.

Rapid lateral and vertical changes in the facies are interpreted as due to rapidly changing local depositional conditions. These were caused by the submerging basement initially forming a steep coast with at least two offshore islands. Marine infilling occurred within former incised river valleys 3 km wide and over 300 m in depth. Erosion of local greywacke contributed to the Opoitian sedimentation, as did a granitic source, probably in North-west Nelson, with materials transported from this latter source by currents propagating through the Kuripapango Strait.

The presence of abundant granite-derived micas in Opoitian strata, yet their absence in the Kapitean strata provide a limiting age for the arrival of micas in Wanganui Basin strata. As the Wanganui Basin depocentre moved southwards, offlap and emergence occurred with Plio-Pleistocene uplift.

The paleo-Moawhango River established its course in the newly uplifted strata, forming superimposed gorges where it cut into exposed basement. Except for initially deposited basal strata, dips in the Neogene marine strata are almost all uniformly consistent with the regional dip. Mapping of the shell limestone beds has shown post-Opoitian development of a small scale (<2 km wide) anticline and a minor associated fault.

To the south of the study area, the Waipipian age Taihape Mudstone overlies the Waiouru Formation. The contact between the two is interpreted to be the Opoitian-Waipipian boundary and thus the Waiouru Formation was deposited within the Opoitian Stage.

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I am indebted to the two officers who have held the position of Commander, Army Training Group Waiouru, during this study, for granting permission to study in the military training area. My thanks to Colonel Clive Sinclair and Colonel Roger Mortlock.

Finally, thanks must go to my wife Pamela for her support and encouragement throughout this study.

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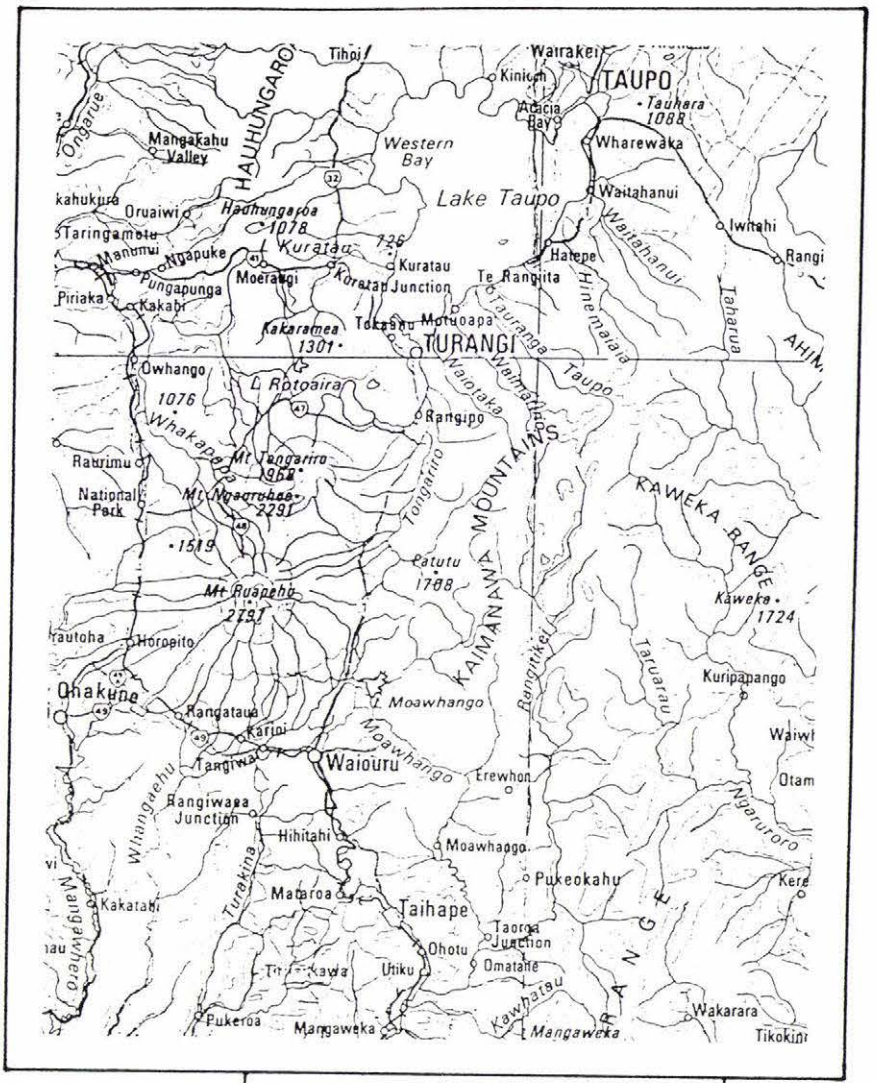

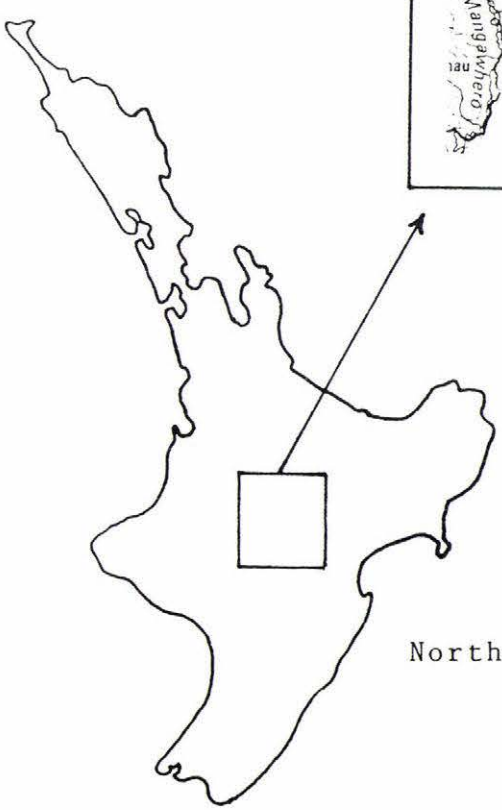

CHAPTER 1

INTRODUCTION

1.0 GENERAL DESCRIPTION

The Waiouru Formation is a Late Tertiary marine deposit lying unconformably on the Torlesse Supergroup in the vicinity of Waiouru. Unconformable contact of Tertiary sediments onto greywacke exposures of remarkably high local relief was noted and reported by Hector (1870, 1871), Park (1887) and Hill (1889). A more detailed description and mapping of the area to the immediate south of Waiouru was conducted by Feldermeyer *et al.* (1943) in reports of the Superior Oil Company. Subsequent descriptions by Kingma (1957a) and Suggate (1978), also reported on the high local relief of the greywacke.

As part of the Tongariro Power Project, the Moawhango Dam and Tunnel were constructed within the Army Training Area to the north of Waiouru. Investigations of the geology of the Dam site and along the line of the Moawhango Tunnel, were recorded by the New Zealand Geological Survey (NZGS), and reported by Ingham (1969, 1972); Duder *et al.* (1977); Hegan (1980) and Beetham and Watters (1985).

These investigations, as well as the NZGS 1:250 000 mapping of Grindley (1960) and the NZGS 1:50 000 sheet by Ker (1991) did not specifically address the conditions that have caused the unusual degree of local relief seen in the greywacke. Basal marine strata were also variously reported to be of Tongaporutuan or Kapitean age.

A personal interest in this area was developed by the author during service with the New Zealand Army, which included two assignments as the military engineer supervising part of the Argo Road construction project. On retirement from the Army, I was determined to investigate the unusual local relief of the greywacke.

Fig 2. MAP OF THE ZONES IN THE ARMY TRAINING AREA AND LOCATION OF FIELD SITES.

(Part of Map NZMS 317, 1:50 000, Waiouru, Ed 2 1990, incorporating parts of NZMS 260 T20 and T 21, 1:50 000 and overprinted with the zone boundaries).

1.1 OBJECTIVE AND SCOPE OF STUDY

The aims of this study were to map and describe the pre-Pliocene relief of the study area; to identify, describe and map the Late Tertiary strata occurring within the study area; and to reconstruct the paleoenvironmental conditions prevalent during the deposition of the Waiouru Formation.

1.2 LOCATION

The study area is in the Central North Island within the Army Training Area at Waiouru (Fig 1). The major settlement is the Army Camp located at Waiouru, with associated housing and a small commercial area serving traffic on State Highway 1 (SH1). The sector of SH1 between Waiouru and Lake Taupo is referred to as the Desert Road.

The use of this area for Army training has seen development of a road network to the east of the Desert Road and has exposed many sections of Late Tertiary strata underlying a cover of Late Quaternary tephra. Due to Army training and safety needs, all access to the area requires a permit from Headquarters, Army Training Group, Waiouru (ATG). The Army has defined internal boundaries within the Training Area delineated as numbered zones. These zones are shown on Fig 2, and are here used as area locations in this text.

Only one zone (Zone 20) is difficult to access, having many unexploded shells. Data in this area has been limited, but being adjacent to the Moawhango Dam, it is balanced by considerable geological data taken from the Dam site during construction.

Within the study area (Fig 2), the Late Tertiary sequence extends from the Moawhango River at an elevation of 520 m, on the southern boundary of the Army Training Area, to further north where isolated remnants of Pliocene marine strata are found on the greywacke basement at an elevation of 1220 m. The bulk of the marine strata in the study area are Pliocene; only one exposure of Kapitean strata having been found in the study area.

The total vertical thickness of Late Tertiary strata is 700 m, but this thickness has to be corrected for post-depositional deformation which has given a dip of approx 3° to the southwest. This is consistent with the North Wanganui Basin regional dip. After this correction, a true stratigraphic thickness of 480 m is preserved for the Late Tertiary strata in the study area.

1.3 METHODS

Exposures of Pliocene-age strata and exposed greywacke were plotted on a 1:25 000 scale map (Appendix A). Pliocene strata were mapped, stratigraphic columns were prepared (Appendix B) and data taken for paleocurrent determinations. One prominent layer of Pliocene strata (Crag reef, Fig 3) was surveyed in detail (Chapter 4) to determine post-depositional deformation. Data collected from seismic investigations during the construction of the Moawhango Dam allowed plotting of some subsurface contours.

Samples were taken for thin-section study where a change in lithology was indicated. Fossils were collected for age and paleoenvironmental determinations.

All map references used in this study are to NZ Infomap 317, Sheet 1 WAIOURU, 1:50 000, Ed 2, 1990. This is a map amalgamating parts of NZMS 260, Sheets T 20 and T 21, and overprinted with the zone boundaries (Fig 2).

1.4 PHYSIOGRAPHY

The study area is located between the Late Quaternary volcaniclastics forming the Mt Ruapheu ringplain and exposed Jurassic greywacke of the Kaimanawa Mountains which forms the regional basement. The distinguishing feature of Pliocene strata in the western part of the study area is the formation of distinctive flat topped hills with accordant summit heights. These are due to gently dipping, near horizontal layers of erosion-resistant calcareous sandstone and shell beds (Fig 4).

The southern toe of the greywacke forming the Kaimanawa Mountains has been mapped as a series of block plateaus (Sporli and Barter 1973), each with a preserved planar surface representing the Late Cretaceous Peneplain of Benson (1935, 1941). The greywacke exposed in the eastern part of the study area forms part of a similar block plateau.

The central portion of the study area is divided by the east-west aligned Home Valley, flanked to the north and south by a moderately dissected landscape of Pliocene sandstones and mudstones (Fig 5). The Home Valley is occupied by the underfit Waiouru Stream, which drains into the Hautapu River, with the saddle at the eastern end of the Home Valley marking the watershed boundary between the catchments of the Hautapu and Moawhango Rivers. Comparison of the Home Valley with its undersized occupying stream strongly suggests that the headwaters of the Waiouru Stream have been captured by the Moawhango River.

Within the catchment of the Moawhango River in the study area, are a series of narrow river gorges cut into the greywacke basement. Between these gorges are two major basins (Zone 27 and Argo basin) where softer Pliocene strata have been preferentially eroded. The approximate eastern rim of the Zone 27 and Argo basins is delineated by the greywacke of the Kaimanawa Mountains.

1.5 CLIMATE

Climatic records for the period 1960-1989, were recorded by the NZ Army-operated Waiouru Weather Station. These climatic records are included in this study by kind permission of Headquarters ATG.

Located at an altitude of 823 m, the climate of Waiouru is strongly influenced by the altitude, with an average annual rainfall of 1140 mm, and a annual daily mean temperature of 9.2° C, (annual mean maximum is 24.5° C and the mean minimum is -6.5° C). Ground frosts are recorded for 27% of the year. The natural treeline is at 1440 m.

Wind directions, as percentages of annual measurement are:

north	10.4	southeast	2.4	west	23.3
northeast	9.9	south	5.4	northwest	11.2
east	11.4	southwest	2.6	calm	23.5

1.6 GENERAL GEOLOGY

The Army Training Area straddles the area of onlap of marine Pliocene strata onto a dissected and tilted greywacke plateau marking the southern exposure of the Kaimanawa Mountains. To the east of the study area (Fig 1), the Kuripapango Strait was open during the Pliocene (Stevens 1974), thus making the Waiouru area the southern coast of the proto-North Island during the Pliocene.

The Pliocene strata in the Waiouru area have been described as, "... overlapping onto an unweathered and highly irregular surface of Kaimanawa Greywacke (Gregg 1960). Locally, sandy blue-grey mud, sand and grit are draped over stacks of greywacke or cover a subsurface landscape of deep valleys and islands. " (Suggate 1978).

The dissected nature of the Late Tertiary greywacke surface in the study area, was first reported by Hector (1870). Kingma (1957a) and Cotton (1957) were the first to mention the pre-Pliocene dissection of the greywacke basement as a "fiord topography", implying a degree of dissection similar to the spectacular glacier-cut valleys and sounds of present day Fiordland.

Tectonic activity is evident at the southern boundary of the study area where the Snowgrass Fault is the most prominent of a group of faults striking northeast/southwest with Pliocene strata downthrown 150 m to the northwest (Feldermayer et al. 1943). Drag folding by the Snowgrass Fault has also formed a dome structure, the Snowgrass Dome, in the Pliocene strata covering the basement.

Fig 3 . Shell limestone layer referred to as Crag Reef on the south side of the Home Valley at GR T21/475889. Crag Reef (arrowed), is approx 7 m thick and underlain by a distinctive layer of calcareous concretions, enabling correlation and mapping over a wide area (Chapter 4).

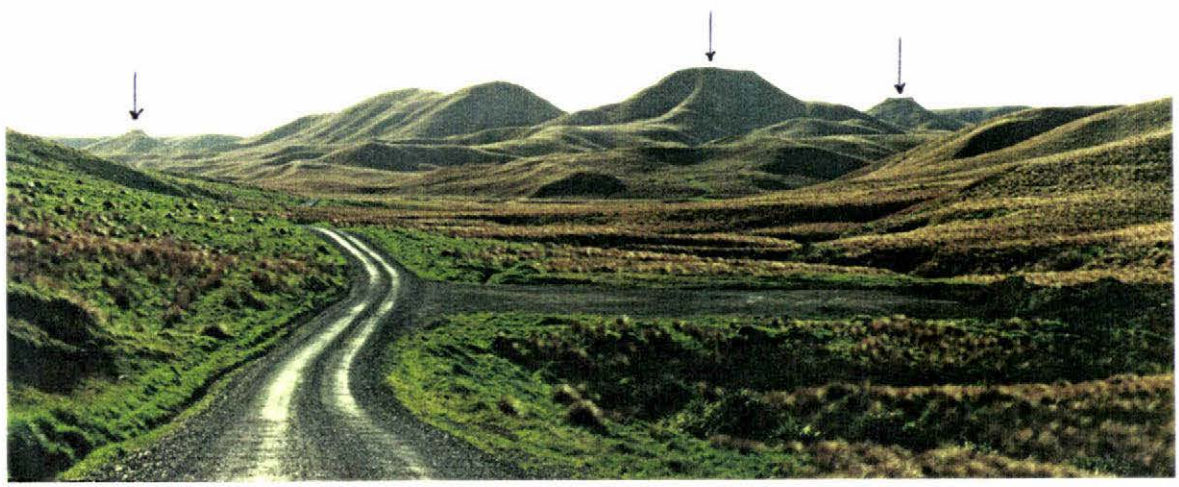

Fig 4 . Looking west towards Waiouru along Home Valley. The hills shown in the background on the north side of Home Valley are of Pliocene strata and comprised of dominantly mudstone and sandstones. Arrows indicate where erosion has removed the softer mudstone and sandstones above the hard shell limestone layer of Crag Reef to give a distinctive flat top to each hill. The incised bed of the Waiouru Stream is in the right foreground.

Fig 5 . At GR T21/425897 in Home Valley, looking east away from Waiouru. The Home Valley has been formed in Pliocene sandstones and mudstones of mainly Opoitian age. One exposure of Kapitean age mudstones has been found on the floor of the Home Valley. Crag Reef is visible as an outcrop (arrowed), on the valley sides above the debris mantle covering the lower slopes. The incised bed of the Waiouru Stream is at the right foreground. Flat Top, Auahitotara and Totem are indicated.

Late Tertiary marine strata (mostly of Pliocene age), near Waiouru were previously described as *The Reef Bearing Sands* (Feldermayer et al. 1943); *Waiouru (Reef-Bearing) Sandstone* (Fleming 1959); *Waiouru Sandstone* (Suggate 1978) and as *Waiouru Formation* (Ker 1991). Waiouru Formation is here used in this study to refer to all Late Tertiary strata within the study area.

The marine strata mapped and described by Feldermayer et al. (1943) were identified as Pliocene strata, although later study (Suggate 1978), located older strata of Kapitean age at one location. The Waiouru Formation thus covers from Kapitean to Opoitian time (6-3.6 ma), using stage boundaries as defined by Beu et al. (1990). Bedding of the Opoitian strata is almost undisturbed and measured dips generally conform to the Wanganui Basin regional dip of 3-5° to the southwest. Some very localized areas do show steeper dips, but with the exception of an anticlinal structure identified in this study, these are identified as deposition on initially steeper basement relief.

Pliocene strata in the study area are mainly sandstones and mudstones with layers of hard calcareous sands showing varying amounts of shells and coquina limestone. Here, coquina is defined as porous, friable, coarse-grained, detrital limestone composed wholly or chiefly of broken calcareous fossils (Beu et al. 1980). For this study, both the coquina and calcareous sand layers are jointly referred to as shell limestone beds.

Shell limestone layers appear as marker beds within the study area (Morgan 1919), with one particular shell limestone layer having distinctive field characteristics which allow correlation over a wide area (Chapter 4).