BAY OF ISLANDS

GEOLOGICAL SETTING

GEOMORPHOLOGY The northern part of the mapped area is a many branched "drowned valley" system forming the "Bay of Islands". Whangaruru Harbour in the south-east is another drowned valley. Inland are high hills (up to 426 m a.s.l.) formed of "greywacke"* (**SM6**). Some ridges, mainly in the south-west of the area, are capped by flat-lying remnants of previously more extensive lava flows.

STRATIGRAPHY On the map the rock types are classified according to their composition or **lithology**. In this section of the text the rocks are broadly grouped according to their age following the system used on the 1:250 000 geological map of the area (Kear & Hay 1961).

LITHOLOGY	SYMBOL	GEOLOGICAL AGE
Intertidal deposits, alluvium, terrace deposits, peat, beach sand and gravel, dune sand, and basalt	$A1_1$ $A1_2$ $A1_3$ C1 G1 M1 $S1_1$ $S1_2$ $F6_2$	Quaternary
Rhyolite and dacite	F5	Late Tertiary
Greywacke and argillite	SM6	Early Mesozoic

ROCK TYPES

The **rock types** on this map refer to earth materials of any age or origin, whether loose fragments or solid masses, however shallow or deep in extent, but not to the pedological soil cover.

Weathering (as well as hydrothermal alteration) is a process of physical breakdown and chemical decomposition that produces changes in the rocks in place. It results in generally softer and weaker materials with changes in permeability. In Northland a warm humid climate over a long period of time has produced a widespread mantle of intensely weathered rock consisting of soil and clay that covers and grades down into harder material.

The generalised descriptions given in the legend refer firstly to the unweathered state of the rock materials and secondly to the weathered material.

EXTRACTIVE MINERALS

Production figures and details from quarries and mines are available from Inspector of Quarries, Mines Division, Ministry of Energy, Auckland. Details of groundwater potential are available from N.Z. Geological Survey, Otara.

AGGREGATE The quarries which have produced roading aggregate in this area have all been in greywacke and argillite(**SM6**). Quarries in other rock types have produced material either too weathered or soft for road surfaces other than farm tracks. Some areas of locally derived "greywacke" gravels may have small operation potential.

One quarry, south-east of Pomare Point near Russell, was known to have been producing rock in 1977, 85 280 tonnes have been extracted since 1967.

CLAY Extensive areas of clay formed from weathered greywacke occur throughout this area but none has as yet been worked.

Other areas of clay from weathered lava may have some potential but are probably small in extent.

METALLIC MINERALS Antimony (Sb) Numerous localities have been reported from siliceous zones within the greywacke. Most are small and at present considered uneconomic, but three areas have been worked in the past.
Copper (Cu) Copper in joints has been reported from the Cape Brett area.
Manganese (Mn) A number of thin lenses usually associated with red chert have been prospected, but only one near Russell was mined.

GROUNDWATER Yields varying from nil to 1.4 l/s (1100 gph) have been recorded from greywacke. However the highest known yield in this area is 0.8 l/s from a hole in the weathered greywacke at Russell. A shallow hole in the alluvial gravel flats at Russell yielded 0.3 l/s, but these rates do vary with the seasons.

The main yields, although generally not great, appear to be from the weathered/fresh greywacke rock zone. Sometimes fracture zones encountered well below the water table give good supplies.

Local groundwater authorities and drillers have information relating to specific areas and groundwater supply potential.

SODA SPRINGS At Oronga Bay, at the headwaters of Pomare Bay, Russell, there are a number of soda springs resulting from CO_2 gas bubbling up through the mudflats. Another area of soda springs occurs inland from Whangaruru Harbour up the Mokau Stream.

GEOLOGICAL HAZARDS

EARTHQUAKES Earthquake vibration produces various responses in different rock materials, and topography can also modify the effects. Generally in hard, dense, rock materials no significant amplification of vibration occurs. However, vibration could be amplified significantly in unconsolidated materials, and these could respond by slumping, flowing or settlement, especially if slopes are steep, or if the materials are water saturated (see Slope Instability).

The felt effects of earthquakes are described by the Modified Mercalli (MM) scale of intensities I–XII. Generally earthquakes of MM V or greater are those in which some structural damage could occur. For regional estimates of earthquake risk the intensity figure is an average indication of the expected responses of a range of rock materials. Thus higher felt intensities may be experienced on those materials with increased vibration responses as indicated below.

The frequency of recurrence of felt earthquakes in Northland is low compared with the rest of the country. Smith (1978) has used records of the last 140 years to estimate earthquake risk for New Zealand. In the mapped area, on average ground conditions, it is likely that earthquakes of MM IV could be felt at least once every 50 years. (As a comparison Wellington experiences 4 or 5 MM IV earthquakes each year.) The average time of recurrence of a MM VI earthquake is greater than 100 years, and that of a MM VII earthquake is greater than 500 years.

Within historic times two earthquake epicentres have been recorded as being in this sheet. One during March-April 1830 had an effect of less than MM 4.5, the other during November 1919 registered MM 4–5.

Epicentres originating outside the region have produced felt earthquake effects within this area. For example the 1968 Inangahua earthquake gave a felt intensity of MM IV over this area.

No known active faults are present on this sheet.

Details of earthquake records are available from Superintendent, Seismological Observatory, DSIR, Kelburn, Wellington.

SLOPE INSTABILITY Earth materials can move under the influence of gravity as falls, slides or flows. Slope stability in rock is controlled by both the strength of the rock material and of the rock mass, the strength of the latter depending on the nature and attitude of fractures and bedding planes. Water conditions within the rock mass, and slope angles, are important factors affecting stability. The possible consequences of slope failure include damage to structures, dislocation of communications and services, and blockage of waterways.

Steep slopes in deeply weathered "greywacke" hill country are prone to slipping, especially when a long dry period is followed by heavy rain.

TSUNAMI The long open parts of the coastline in this area are particularly vulnerable to seismic sea waves. Three tsunamis have been recorded in historic times along the east coast of Northland.

FLOODING The area is subject to intense tropical storms. Flooding and associated scouring is possible in the narrow valleys inland.

COASTAL EROSION: Removal or deposition of coastal material by the sea is possible in storms and extreme tides. Offshore dredging can also result in changes in coastlines through the disturbance of coastal profiles and the natural readjustment to equilibrium. Gibb (1981) describes techniques for assessing coastal erosion and accretion in the East Cape region which possibly could be applied to areas in Northland.

*"Greywacke" is used here as a collective term including both sandstone and mudstone. It is also used in this sense against quarries on the map face.

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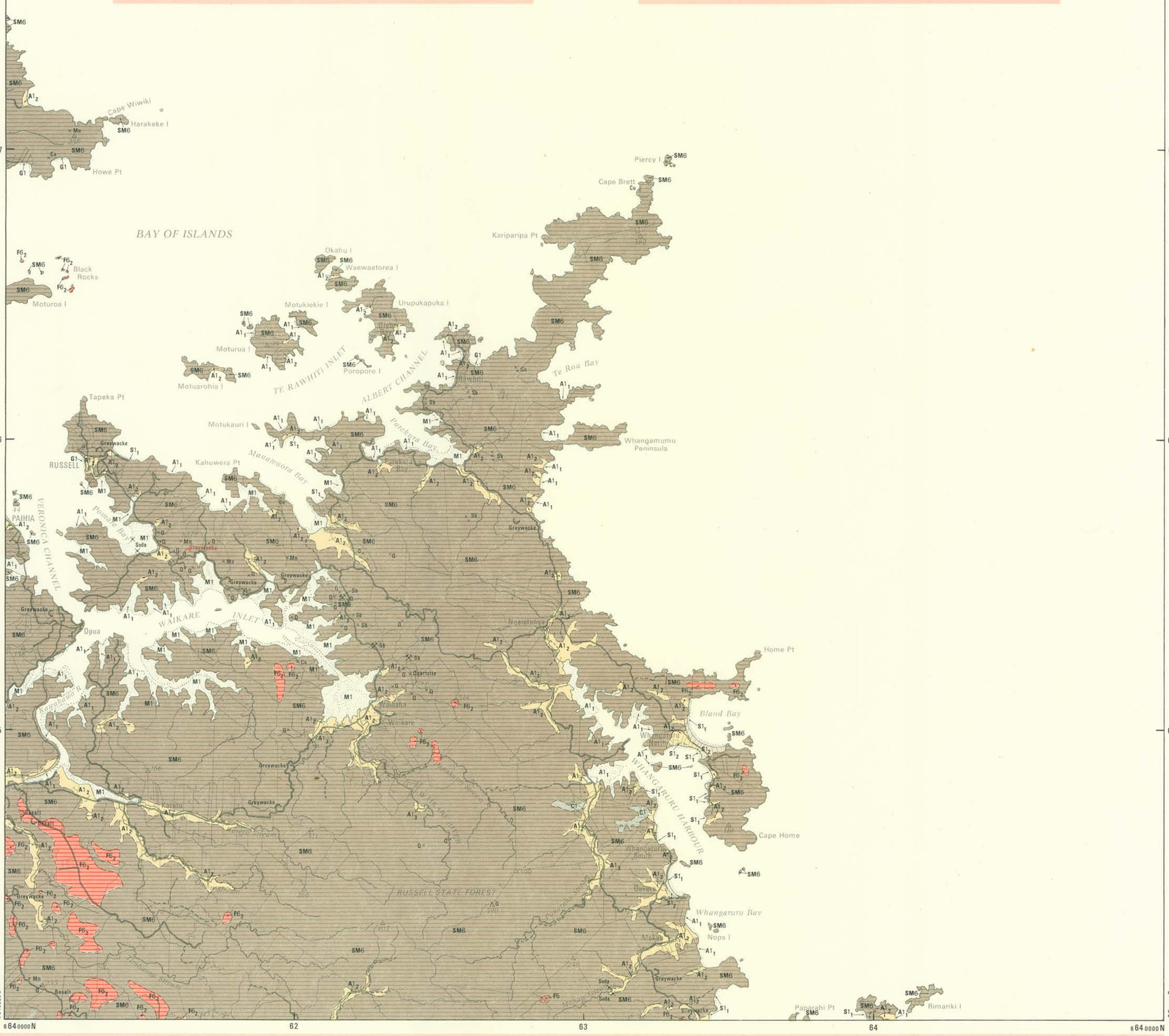


INTRODUCTION

Rock types maps are intended to help planners and land users to:
i) identify the characteristics of near surface rock types;
ii) recognise areas of existing and potential mineral resources;
iii) become aware of geological hazards.

ROCK TYPE DESCRIPTIONS (LITHOLOGIES)

The map unit symbols are listed alphabetically within the two major rock type categories - sedimentary and igneous. The first letter of each symbol indicates the major lithology, and the second letter (where present) a significant interbedded lithology. The numeral indicates the typical hardness (see Physical Characteristics table) of the unweathered rock material, and the subscript numeral indicates variation.

The description for each map unit may include common name, distinctive landform, colour, hardness, grain size, bedding, fracturing and chemical composition. Major and minor lithologies are described and also the weathered material in terms of changes in colour, hardness and grain size. Range of depth of the weathered mantle is also given. (See also "Definition of Descriptive Terms").

SEDIMENTARY ROCK TYPES

ALLUVIUM

$A1_1$ Undifferentiated intertidal deposits: very fine to coarse grained mud, sand, shell and gravel; unconsolidated.

$A1_2$ River bed and flood plain alluvium: very fine to coarse grained, mud and sand, some gravel and peat; unconsolidated to very soft; unweathered.

$A1_3$ Terrace alluvium: up to 10 m above stream or sea level, mainly mud and sand; very soft to soft; moderately to slightly weathered to a very soft clay to depths of 2 m.

PEAT

C1 Organic swampy deposits usually less than 4 m in depth, some mud, and sand; very soft.

GRAVEL AND CONGLOMERATE

G1 Beach and stream gravel: coarse to very coarse rounded rock fragments, some sand; unconsolidated to partially cemented; unweathered.

MUD AND MUDSTONE

M1 Intertidal mud: very fine to fine grained; unconsolidated.

SAND AND SANDSTONE

$S1_1$ Beach sand: mostly quartz and feldspar, medium grain size 150–380 microns; unconsolidated; unweathered.

$S1_2$ Active sand dunes: mostly quartz and feldspar, fine grain size. Unconsolidated; unweathered; moving dunes, some areas partially fixed.

SM6 Sandstone and mudstone (greywacke and argillite): Medium to dark grey, fine to medium grained sandstone interbedded with grey to black mudstone and minor siliceous, igneous and calcareous rocks, thinly to thickly bedded with some massive units, closely fractured and veined; moderately hard to very hard. Weathered to yellow-brown soft sandy clay to depths of 30 m.

IGNEOUS ROCK TYPES

EXTRUSIVE ROCK

F5 Rhyolite and dacite: light coloured finely crystalline, massive; moderately hard to very hard. Weathered to whitish clay, with silica fragments.

$F6_2$ Basalt: dark grey to black, locally red, fine to medium grained crystalline flows and remnant cones, intruded by minor more coarsely crystalline basaltic plugs and dikes; hard to very hard, massive, widely fractured. Weathered to reddish brown friable clay to depths of 30 m.

PHYSICAL CHARACTERISTICS OF UNWEATHERED ROCK TYPES, AND A GUIDE TO EXCAVATION METHODS

*TERM	NUMBER & PATTERN	*DIAGNOSTIC FEATURE	§GUIDE TO EXCAVATION METHODS
Very Hard	7	Not scratched with knife or hammer point.	Explosives generally required.
Hard	6	Scratched with knife or hammer point only with difficulty.	Heavy machinery generally required; explosives will be needed where rocks widely fractured.
Moderately Hard	5	Scratched with knife or hammer point.	
Moderately Soft	4	Grooved or gouged to depth of about 3mm by firm pressure on knife or hammer point.	Machinery required; explosives may be needed where rocks widely fractured.
Soft	3	Grooved or gouged readily with knife or hammer.	Machinery required.
Very Soft	2	Carved with knife or scratched with finger nail.	Can be dug with spade, light excavators suitable.
†Unconsolidated	1	Disaggregated by hand, or easily moulded.	Can be dug by hand.

*Refers to hand sized samples of fresh rock of the map unit.

§Fractures can have a significant effect on the ease of excavation; e.g. hard rocks if closely fractured, may be excavated as readily as softer material. (see table on fracture spacing).

†Units such as gravel or scoria are unconsolidated as a mass but consist of fragments with individual hardnesses of up to 7.

DEFINITION OF DESCRIPTIVE TERMS

GRAIN SIZE

SIZE	CRYSTALLINE ROCK	UNCONSOLIDATED SEDIMENT	CONSOLIDATED SEDIMENT	FRAGMENTAL VOLCANIC DEBRIS
	glassy			
less than 2 microns	very fine grained crystalline	clay } mud	claystone } mudstone	tuff
2 to 60 microns	fine grained crystalline	silt } mud	siltstone } mudstone	tuff
60 microns to 2mm	medium grained crystalline	sand	sandstone	tuff
2 to 60mm	coarse grained crystalline	gravel	scree (angular) } conglomerate } breccia (angular)	volcanic breccia
more than 60mm	very coarse grained crystalline	cobbles and boulders	scree (angular) } conglomerate } breccia (angular)	volcanic breccia

BEDDING

The following terms denote bedding thickness ranges:

thinly bedded	less than 200mm
medium bedded	200–600mm
thickly bedded	more than 600mm

FRACTURING

The following terms denote fracture spacing ranges:

closely fractured	less than 20mm
moderately fractured	20–200mm
widely fractured	more than 200mm

SYMBOLS

- Rock type boundary – known
- Rock type boundary – uncertain
- ×Mn Sample site or mineral outcrop with chemical symbol (N.B. Q = quartzite or chert)
- Quarry or pit (closed)
- Quarry or pit (operating) — Quarried material indicated eg. Crystalline Limestone
- Underground mine (mined material indicated e.g. Silver)
- × Spring (mineral composition indicated when known e.g. Soda)
- 1957 0.1 l/s Water bore (with sample pumping rate in litres per second (l/s), and date when known)

COMPILATION METHODS

This map was compiled by D.R. Petty, New Zealand Geological Survey, DSIR, and is a compilation of all available information. Alluvial areas and some distinctive landforms were delineated from aerial photos (scale 1:15 840).

Rock type and extractive minerals information were obtained from manuscripts, maps and notes prepared for publication by Bowen (1968), Kear and Hay (1961), Ferrar (1925) and Petty (1974, 1978). Information was also obtained from records of the NZ Mines Division (1966-77) and various unpublished reports filed at the Otara District Office of NZ Geological Survey.

RELIABILITY

This is a small scale map, therefore rock type units and their boundaries are generalised. The reliability of the content and position of unit boundaries is influenced by the lack of detailed field mapping, the uneven distribution of observation points, the variety of rock materials within some units, the degree of distinctiveness of the topography as seen on aerial photos, and the variability in the accuracy and completeness of the existing descriptions of the rock types. Small significant areas have been exaggerated.

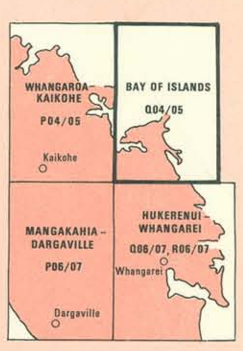
For more detailed information on selected areas write to:
The Director,
N.Z. Geological Survey, DSIR,
P.O. Box 30-368,
Lower Hutt.

Note: This map should not be used for planning major engineering projects, large scale quarrying operations, or detailed work, for which individual investigations are required.

Refer to this map as:
Petty, D. R. 1981: "Bay of Islands"
NZMS 290 Sheet Q 04/05, 1:100 000.
New Zealand Land Inventory, Rock Types.
Department of Lands and Survey, Wellington, New Zealand.

This map is one of a series. Themes mapped in this study are :– Land Tenure and Holding, Rock Types, Soils, Existing Land Use, Wildlife, Indigenous Forest.

SHEET INDEX



Area covered by "Rock Type" maps.

COMPILATION NOTE:- The base map is compiled from the NZMS 1 series (1:63360) dated 1969, 70, 77.

EDITION 1 1981

NEW ZEALAND LAND INVENTORY

SCALE 1 : 100 000

Metres 1000 0 1 2 3 4 5 6 7 8 Kilometres

REFERENCE

WHANGAREI	Cities
KAIKOHE	Towns
Rauhora	Settlements
	State highways
	Other roads
	Tracks
	Railways
	Rivers and streams
	Trig stations
	Vincula (separate parcels under same ownership)
	Land holding boundaries
	Sand and mud
	Wetlands

HEIGHTS ARE IN METRES ABOVE MEAN SEA LEVEL

This map is drawn on the New Zealand Map Grid Projection, a minimum-error conformal projection. The grid is the New Zealand Map Grid, showing coordinates in metres in terms of the Geodetic Datum 1949, based on the International (Hayford) Spheroid.

The smallest area mapped is generally not less than 10 hectares. Calculation of areas from this map should be within the limitations of scale. For example, individual areas should be rounded to the nearest 5 hectares. Accumulated areas should be rounded to the nearest 50 hectares.

AREAL SCALE
500 hectares divided into units of 25 hectares

Compiled by D.R.Petty,
New Zealand Geological Survey,
Department of Scientific and Industrial Research.

Published by the Department of Lands & Survey, New Zealand, under the authority of W.N. Hawkey, Surveyor General.

P.D.Hasselberg, Government Printer, Wellington, New Zealand.