MANGAWHAI - WARKWORTH

6580000 N GEOLOGICAL SETTING EXTRACTIVE MINERALS most of the sheet area. yields and potential is availabe from N.Z. Geological Survey, Otara, or Auckland Regional Water Board, Auckland $Eroded flows of dacite (~\textbf{F6}~) and basalt (~\textbf{F6}_2~) of late Tertiary age occurs with ~\textbf{SM6}_1~. Mesozoic greywacke and argillite (~\textbf{SM6}~) underlies ~\textbf{SM5}_1~ at depth and is exposed at several places along the coast, and forms (~\textbf{SM6}_1~) and (~\textbf{SM$ ROCK AGGREGATE: Greywacke and argillite (SM6) and basalt (F62) are sources of good quality rock for crushing as aggregate, but the depth of weathering over most inland areas of these units is such that much stripping of overburden is needed before sound rock may be obtained. Coastal exposures and steep inland slopes have a thinner Muddy limestone (152) and fractured mudstones (M4, M42) of early to mid Tertiary age occur at several places weathered mantle than elsewhere and are therefore more likely to be suitable quarry sites. Conglomerate (65_1) and beach gravel (61) are local sources of aggregate. SAND: Sand occurs in dune and beach deposits, and also offshore. Much beach and subtidal sand has been removed In the south of the sheet the coastline is extremely irregular, with bays and harbours indicating drowned topography. To the north, the long sandy beach backed by sand dunes has been built up in very recent times. from the coastal areas on this sheet. Between 1955 and 1967 an estimated yearly average of over 100 000 m³ was removed from the coast between Mangatawhiri Spit and Ocean Beach north of this sheet (Schofield 1975). The removal of sand may promote erosion, over and above that which naturally occurs (Schofield, pers. comm). $\textbf{STRATIGRAPHY} \ \ On the map the rock types are classified according to their composition or$ **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 content of the text the rocks are broadly grouped according to their age following the system used on the 1:250 000 geological content of the text the rocks are broadly grouped according to their age following the system used on the 1:250 000 geological content of the text the rocks are broadly grouped according to their age following the system used on the 1:250 000 geological content of the text the rocks are broadly grouped according to their age following the system used on the 1:250 000 geological content of the text the rocks are broadly grouped according to their age following the system used on the 1:250 000 geological content of the text the rocks are broadly grouped according to their age following the system used on the 1:250 000 geological content of the text the rocks are broadly grouped according to their age following the system used on the 1:250 000 geological content of the text the rocks are broadly grouped according to the rocks are broadly grouped acMANUFACTURING MATERIALS FELDSPAR SAND: Feldspar sand is used in glass manufacture and in the ceramics industry, and is dredged from the map of the area (Thompson 1961). The stratigraphic relationships of the early to mid Tertiary rock types are uncertain as, in some areas, they may have been disrupted and displaced from their original site of deposition during the mid to late Tertiary and may overlie older or younger rock types. LIMESTONE: Muddy limestone (L52, calcium carbonate content 50–75%) is quarried from several places on this sheet and crushed for use as a fertiliser. Reserves are large.

SERPENTINITE: A number of bodies of scrpentinite (U5) occur within M42; some have been quarried for use in the ROCK TYPE GEOLOGICAL AGE fertiliser industry. Reserves are small on this sheet. deposits, beach sand, fixed and active S12 dunes, beach gravel Ores of copper and manganese were mined from associated chert, quartzite and spilite deposits within greywacke and argillite (SMe) on Kawau Island from 1842 until the 1890s. Although the largest deposit produced some high grade ore, the average grade mined was 2–4% copper. The old workings are now flooded by the sea. Williams (1974) estimated possible reserves of copper ore at up to 24 kilotonnes. Some high grade manganese ore was mined but interbedded sandstone and mudstone L5₁ L5₂ M4₁ M4₂ the deposits were small; reserves are unknown but are probably small. GROUNDWATER Interbedded greywacke and argillite On this sheet the most productive source of groundwater is interbedded sandstone and mudstone (SM5,), from which yields of up to 30 litres per second have been obtained. Fracturing and consequent increased permeability of the rock mass are needed for high yields (Petty 1974). Areas of alluvium and sand may yield water at rates of up to 4 litres per second (op. cit.) although very high yields have been obtained from the Omaha Flats area (Auckland Regional Water Board, 1977). Bores need to be sited away from surface water which may contaminate groundwater with organ or saline material. Fine grained rock types (15_2 10_2 $10_$ Volcanic breccia and tuff, rhyolite and dacite, basalt nited but shows the known yields in certain places as examples of DISTINCTIVE LANDSCAPE FEATURES AND MINERAL EXTRACTION **ROCK TYPES** The existence of distinctive natural landforms with either scenic, recreational or scientific importance could conflict with some mineral extraction proposals. The overall effects of extraction operations can diminish landscape appeal, The rock types on this map refer to earth materials of any age or origin, whether loose fragments or solid masses nowever shallow or deep in extent; but not to the pedological soil cover. induce or accelerate erosion, alter water quality, and reduce the suitability of the land for other future uses. The undesirable Weathering (as well as hydrothermal alteration) is a process of physical breakdown and chemical decompositions onsequences of mineral extraction projects should be identified by the community before proposals are approved that produces changes in the rocks in place. It results in generally weaker and softer 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 In this map area, there are several areas with a distinctive landscape, whose wise use deserves consideration before land use decisions are made. The coastline from Mangawhai Heads to Pakiri, and further south at Omaha and Snells Beach, is a potentially significant recreational asset. Onshore or offshore sand removal from these areas can detract from their landscape value by physical modification, and may also accelerate coastal erosion. descriptions given in the legend refer firstly to the unweathered state of the rock types and secondly, to the weathered GEOLOGICAL HAZARDS EARTHQUAKES: Earthquake vibration produces various responses in different lithologies, and topography can also modify the effects. In hard, dense rock materials, no significant amplification of vibration generally occurs. However, vibration can be amplified significantly in unconsolidated materials, which may respond by slumping, flowing or settlement, especially if slopes are steep, or if the materials are water saturated. (See Slope Instability).

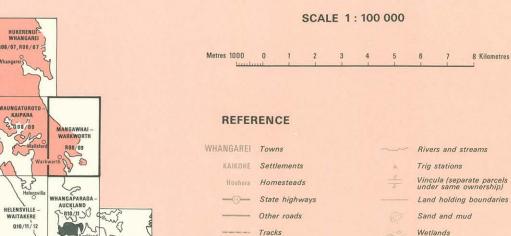
The felt effects of earthquakes are described by the Modified Mercalli (MM) scale of intensities I—XII. Generally, earthquakes of MM V or greater are those in which some structural damage occurs. In regional estimates of earthquake risk the intensity figure given is normally an indication of the average expected response of a range of lithologies.

Thus higher felt intensities may be experienced locally on materials which cause increased vibration responses, as 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 felt intensity MM V could be felt at least once every 50 years. The average time of recurrence of MM VI earthquakes is greater than 100 years, and that of MM VII earthquakes No known active faults are present on this sheet 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 downslope under the influence of gravity as falls, slides or flows.
Slope stability in rock is controlled by the strength of both the rock material and 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 angle, are important factors affecting stability. The possible consequences of slope failure include damage to structures, dislocation of communications and services, and blockage of waterways.

Week and early lithogenes who are the same and blockage of waterways. Weak and soft lithologies such as M4, and M4, are susceptible to instability in either man-made or natural slopes, and may require careful engineering to minimise the likelihood of failure. Areas where thick mantles of weathered material occur are also susceptible to slipping or slumping, especially on steeper slopes (for example, parts of \$M6₁ and \$M6.)
FLOODS: Floods may inundate low lying areas, and can cause erosion of land surfaces and stream and river banks, and deposition of sediment on lowland areas. Hydrological information relating to frequency and depth of flooding should be sought from Ministry of Works and Development, Auckland, or Northland Catchment Commission all coastal areas. From past records their frequency is low. A tsunami warning system is operated by Seismological 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. REFERENCES AUCKLAND REGIONAL WATER BOARD 1977: Omaha-Leigh Water Resources Study. Auckland Regional Water Board Technical Publication No 4, 165 pp.

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N.Z. Journal of Geology and Geophysics 18(1): 109–127. SMITH, W.D. 1978: Earthquake Risk in New Zealand: Statistical Estimates. N.Z. Journal of Geology and Geophysics 21(3): 313-27. TARVYDAS, R.K. 1966: The Geology of the Waipu District, North Auckland. Unpublished M.Sc. Thesis, lodged in the Library, ERHOUSE, B.C. & FLEMING, C.A. 1975: Serpentine Deposits of Southern Northland. In Industr N.Z. Department of Scientific and Industrial Research Information Series No. 106: 21–89. HAURAKIGULF**NEW ZEALAND LAND INVENTORY** SHEET INDEX SYMBOLS This map is drawn on the New Zealand Map Grid Projection, a inimum-error conformal projection. The grid is the New Zealand Map Grid, showing coordinates in metres in terms of the Geodetic SCALE 1:100 000 Datum 1949, based on the International (Hayford) Spheroid.

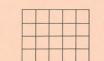


COMPILATION NOTE:- The base map is compiled from the NZMS 1 series (1:63360) dated 1967,69,71,74

This map is one of a series. Themes mapped in this study are :-Land Tenure and Holding, Rock Types, Soils, Existing Land Use, **EDITION 1 1982** Wildlife,Indigenous Forest.

----- Railways

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



AREAL SCALE units of 25 hectares



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Surveyor General. Wellington, New Zealand,

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nical symbol (N.B. Q = quartzite or chert Spring (mineral composition indicated when known e.g. Soda

RELIABILITY

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

ALLUVIUM SEDIMENTARY ROCK TYPES tiated intertidal deposits: mud, sand, gravel and shell; unconsol-

plain deposits up to 60 m thick; unconsolidated to very soft, unweathered

Alluvium: mud, sand and gravel with minor peat, forming terrace deposits up to 10 m above stream or river beds, deposits up to 30 m thick; unconsolidated to very soft. Unweathered, or weathered to brown stained material to depths

GRAVEL AND CONGLOMERATE Gravel: hard, rounded greywacke pebbles; unconsolidated. Unweathered.

Conglomerate: gravel to boulder size angular to rounded fragments of basalt and andesite in a poorly sorted fine grained matrix thickly bedded; moderately hard to hard. Weathered to moderately soft fragments in a soft brown silty clay to depths of 10m.

Conglomerate: angular to rounded gravel to cobble sized greywacke frag ments in a matrix of calcareous mudstone or sandstone, medium to thickly bedded and moderately hard to hard, with minor crystalline limestone (L5₁) and greensand († s4). Weathered to moderately soft fragments in a slightly

Crystalline limestone: medium-grained crystalline calcium carbonate containing some sand grains, with minor greensand († §4), thinly to medium bedded and widely fractured; moderately hard to hard. Weathered to brown

Muddy limestone: grey, 50–75% calcium carbonate, closely fractured, in places interbedded with minor greensand (1 s₄) and mudstone ($_{MA_{1}}$): moderately hard to hard. Weathered to brown very soft slightly calcareous

MUD AND MUDSTONE

udstone: grey, brown and green, thinly bedded and closely fractured, locally calcareous or siliceous, minor muddy limestone (15_2) and greensand († S4); moderately soft to moderately hard. Weathered to soft clay to

Mudstone with blocks: matrix of closely fractured mudstone containing variably sized (cm - km) blocks of calcareous, non-calcareous or siliceous lithologies ($M4_1$ 1M5 $L5_2$ 18_4 185_2 18_5); matrix moderately soft, blocks of variable hardness. Weathered to soft clay to depths of 10 m with athering of blocks as given in descriptions; unstable even on gentle

places; locally calcareous; moderately soft to moderately hard. Weathered

SAND AND SANDSTONE Sand: feldspathic, with some quartz and minor shell fragments, forming intertidal and beach deposits; unconsolidated.

Sand: feldspathic with some quartz, minor dark minerals and clay, forming fixed dunes; unconsolidated to very soft. Unweathered or weathered to brown stained very soft clayey sand to depths of 5 m. carbonate content up to 20%, thickly bedded and moderately fractured, with minor interbedded grey mudstone; moderately hard. Weathered to soft,

brown, non-calcareous silty clay to depths of 10 m. Interbedded sandstone and mudstone; grey quartz-feldspar sandstone; thinly to thickly interbedded with grey mudstone, moderately to widely fractured, with rare beds of medium to coarse grained volcanic breccia; moderately hard. Weathered to soft, yellowish brown silty clay to depths of

Interbedded sandstone and mudstone (greywacke and argillite): blue-grey quartz-feldspar greywacke sandstone, thinly to thickly interbedded with dark grey argillite mudstone; closely to widely fractured and quartz veined. locally very siliceous with minor chert, quartzite and spilite beds (outcrops

IGNEOUS ROCK TYPES

of chert or quartzite are marked on the map with a QI; hard to very hard. Weathered to soft brown sandy clay with harder cores to depths of 30m.

VOLCANIC BRECCIA Breccia and tuff: medium to coarse angular to sub-rounded fragments of very fine to medium grained crystalline andesite and basalt: in places interbedded with fine to medium grained tuff, widely fractured: moderately hard to hard. Weathered to soft reddish clay to depths of 10 m.

Rhyolite and dacite: flows and domes of glassy and very fine to medium grained crystalline rhyolite and dacite, moderately fractured; moderately hard to very hard. Weathered and hydrothermally altered to soft, white or brown halloysitic clay to depths of 30 m.

Weathered to soft, brown clay to depths of 20 m.

ignesium content up to 40%), commonly very closely fractured; mod-tely hard. Weathered to reddish clay to depths of 10 m.

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

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

		UNCONSC		CONSOLIDATED	FRAGMEN VOLCAN
less than 2 microns 2 to 60 microns 60 microns to 2mm 2 to 60mm more than 60mm	CRYSTALLINE ROCK glassy very fine grained crystalline fine grained crystalline medium grained crystalline coarse grained crystalline very coarse grained crystalline	clay mud silt sand gravel cobbles and boulders	scree (angular)	claystone siltstone sandstone conglomerate (angular)	tuff volcani- breccii
		Dodiacia			
BEDDING		boulders			
	denote bedding thickness ranges:				
	denote bedding thickness ranges: less than 20				
The following terms of	less than 20	Omm			
The following terms of thinly bedded	less than 200 d 200-600mm	Omm			
The following terms of thinly bedded medium bedde	less than 200 d 200-600mm	Omm			
The following terms of thinly bedded medium bedded thickly bedded	less than 200 d 200-600mm	Omm			
The following terms of thinly bedded medium bedded thickly bedded	less than 20 d 200-600mm more than 6i	Omm Omm			
The following terms of thinly bedded medium bedded thickly bedded	less than 20 d 200-600mm more than 6i denote fracture spacing ranges: d less than 20m	Omm Omm			

DEFINITION OF DESCRIPTIVE TERMS

HEIGHTS ARE IN METRES ABOVE MEAN SEA LEVEL

This map was compiled by G.S. Markham[†]and T.F. Crippen*, N.Z. Geological Survey, Ota All available lithologic information was first plotted on to a topographic base map (NZMS 1 scale 1.63 360). Rock type unit boundaries were delineated by use of lithologic information

and B.N. Thompson and D. Kear (1959–60; field sheet scale 1:63 360). Publications, theses in geology and unpublished N.Z.G.S. reports were also referred to (see references). Now with Water and Soil Division, M.W.D., Aokautere Science Centre, Palmerston North † Now at Joint Centre for Environmental Sciences, University of Canterbury, Christchurch

Markham, G.S.† and Crippen. T.F.* 1981: Mangawhai-Warkworth NZMS 290 Sheet R08/09,1:100 000. New Zealand Land Inventory, Rock Types. Department of Lands and Survey, Wellington, New Zealand.