THE NEW ZEALAND SOIL CLASSIFICATION

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From : The Living Mantle, Soils in the New Zealand Landscape

The New Zealand Soil Classification

Since the first edition of this book was published, a new soil classification has been developed for New Zealand (Hewitt 1993). This chapter summarises the new classification and provides a table to correlate the class names with the terms used throughout the book.

Reasons for soil classification

Glancing through the pages of this book, gives an impression of the large variety of soils and environments in New Zealand. This variation is a source of endless fascination to the scientist, but it can be confusing to someone seeking to gain a broad understanding of New Zealand soils in relation to landscapes and land uses. This is where soil classification can provide a sense of the underlying order and pattern needed to assist understanding of New Zealand's soils and their landscapes.

Much of science is concerned with understanding the detailed workings of the natural world. Every so often we must stand back and review what we have learned by synthesising the big picture. Soil classification is one such big picture, which in itself generates new knowledge and provides a platform for further research.

Unlike plants and animals, soils are hidden beneath our feet. For this reason, soil maps showing the distribution of contrasting soil types can help farmers and others who use the land. These soil types are grouped into classes based on soil classification. The soil classes provide a concise means of communicating the properties of soils shown on a soil map.

Soil databases contain large amounts of information that can be manipulated and analysed statistically without the need for soil classification. Eventually scientists must relate their information to other knowledge, comprehend its meaning in a regional or national context, and communicate this to non-specialists. Soil classification is part of the interface with, and synthesis of, database information.

Origin of the New Zealand Soil Classification (NZSC)

Soil classification in New Zealand was begun by Maori horticulturalists who recognised and named classes that were relevant to the establishment and management of their gardens, in particular, kumara gardens. They recognised classes such as oneharuru (a light but good sandy loam) and onetea (white soil from sandy volcanic material). The need for soil classification has been part of human activity in New Zealand since the arrival of the first Polynesian canoe.

Soil classification on a comprehensive national scale was not developed until 1948. The pioneer New Zealand soil scientist, Norman Taylor, developed the New Zealand Genetic Classification which recognised "soil groups" and related them to the environmental factors that most influenced their character (Taylor 1948; Taylor and Pohlen 1962, 1968). Knowledge of these relationships helped the prediction of soil classes from observations of geology, landscape, climate and vegetation. Such predictions enabled rapid progress in the broad scale exploratory mapping of New Zealand soils.

By the late 1970's, Taylor's New Zealand Genetic Soil Classification was becoming outdated. Soil classes were vaguely defined so that only experts could easily identify the correct class for many soils. The relationships between soils and environment that were useful at a broad scale were less useful for making soil maps at more detailed scales. Much new soil information was becoming available that could not be explained within the framework of the old system. A new synthesis was needed.

The New Zealand Soil Classification was developed in the 1980s. The top three levels of the classification (orders, groups, and subgroups) were described by Hewitt (1993) and the fourth level (soilforms) by Clayden and Webb (1994). The new classification grew out of the New Zealand Genetic Soil Classification and, where possible, preserved its useful features. The new classification was also influenced by local experience in testing the United

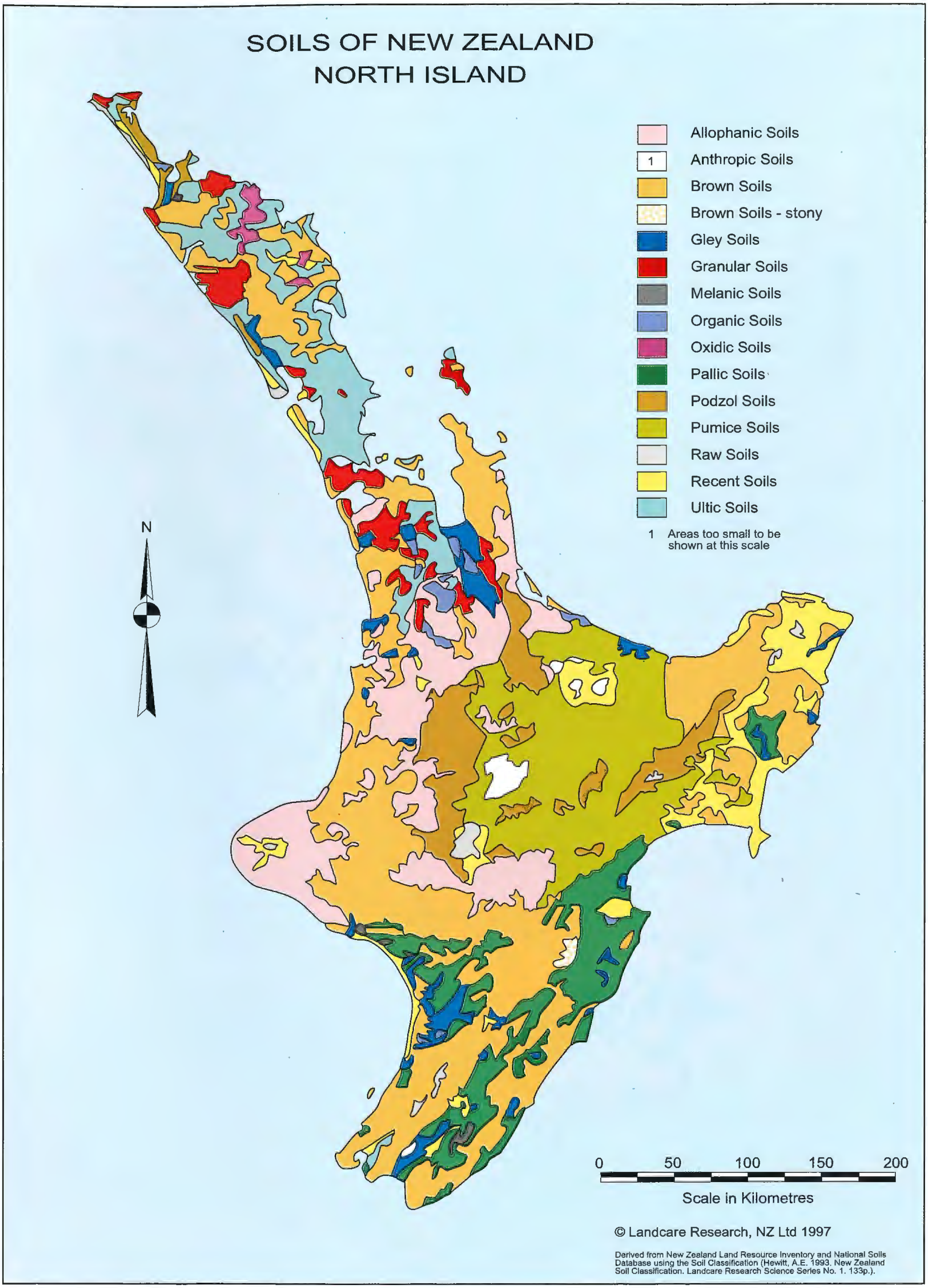
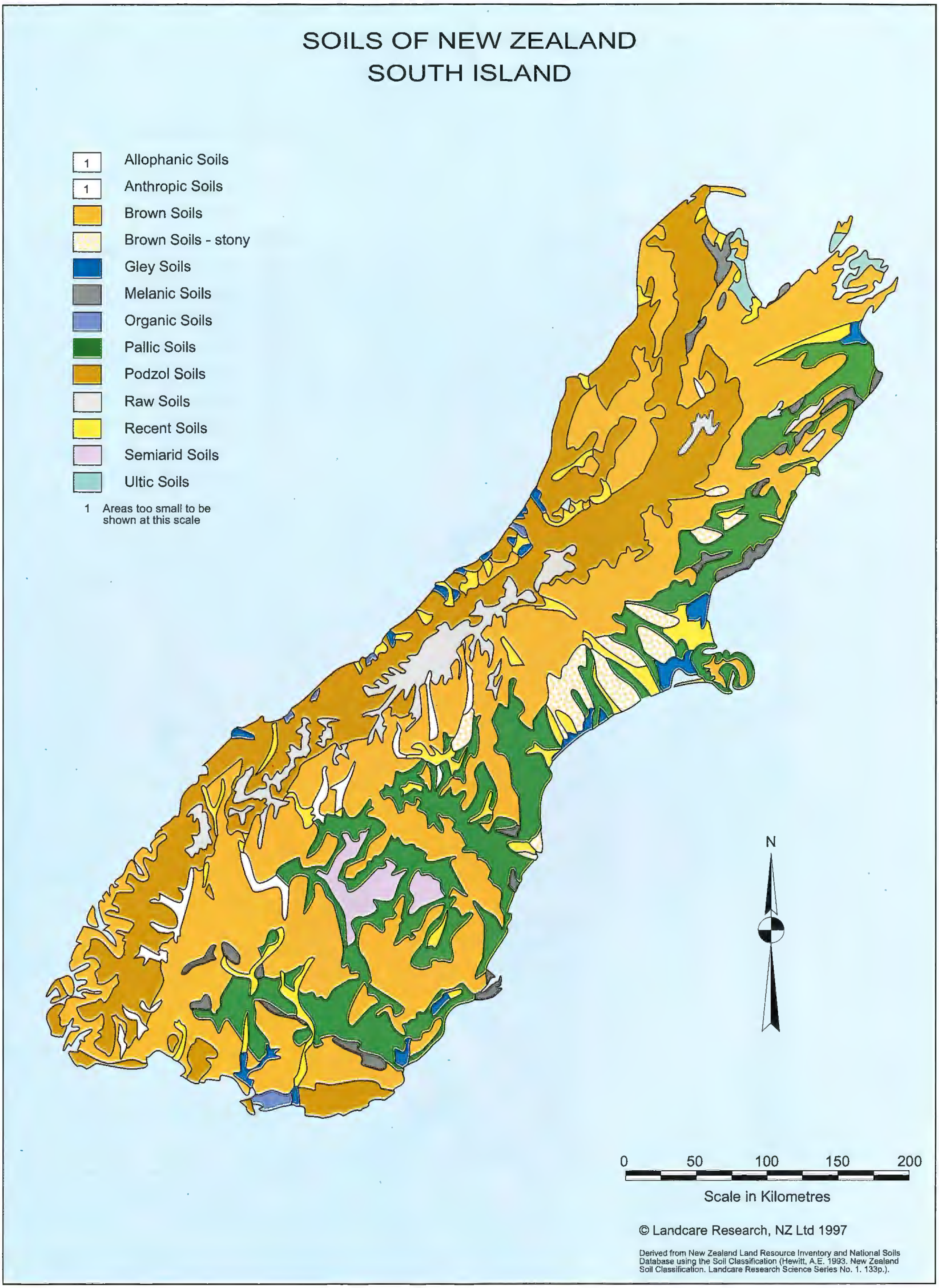


FIG. A1.

Map of distribution of soil orders of NZSC in North and South Islands of New Zealand.


SOILS OF NEW ZEALAND
SOUTH ISLAND
1 Allophanic Soils
1 Anthropic Soils
Brown Soils
Brown Soils - stony
Gley Soils
Melanic Soils
Organic Soils
Pallic Soils
Podzol Soils
Raw Soils
Recent Soils
Semiarid Soils
Ultic Soils
1 Areas too small to be shown at this scale
N
0 50 100 150 200
Scale in Kilometres
© Landcare Research, NZ Ltd 1997
Derived from New Zealand Land Resource Inventory and National Soils Database using the Soil Classification (Hewitt, A.E. 1993. New Zealand Soil Classification. Landcare Research Science Series No. 1. 133p.).

States soil classification system "Soil Taxonomy" (Soil Survey Staff 1975, 1996; Leamy et al. 1983). The resulting classification represents the best attempt to classify New Zealand soils, at our current state of knowledge. As knowledge and understanding of soils grows, further revisions will be necessary.

Principles underlying the NZSC

Development of the NZSC was guided by the following principles.

- Classification should be hierarchical with generalised and detailed levels.
- Classification should be based on the similarity of observable and measurable soil properties, rather than on theories of how the soils formed.
- Classes should be designed to allow many accessory statements to be made about them.
- Differentia should be based on soil properties that can be reproducibly and precisely measured or observed.
- Differentia should, where possible, allow classification of soils in the field.
- Class names should be words that suggest some of the essential soil properties.
- Where possible, continuity with successful parts of the New Zealand Genetic Classification should be maintained.
- Classification must be valid for all the main islands of New Zealand.

Soil names and structure of the NZSC

Names of soil classes in the NZSC are designed to provide links to the older New Zealand Genetic Soil Classification, and where possible to suggest characteristic properties of the soils. The meaning of the soil order names is given in Table 1.

TABLE 1.

The broad meaning and origin of NZSC soil order names.* (Taylor and Pohlen 1968)

Soil order	Meaning	Origin
Allophanic Soils	Allophane dominant	Mineralogy
Anthropic Soils	Made by people	Classical name from Anthropogenic
Brown Soils	Brown colour	Brown soils of Europe
Gley Soils	Gley soils (water logged)	NZ Genetic Soil Classification
Granular Soils	Fine stable structure	NZ Genetic Soil Classification
Melanic Soils	Dark coloured	Name new to the NZSC based on the colour
Organic Soils	From plants	NZ Genetic Soil Classification
Oxidic Soils	Oxide dominated	Soil Taxonomy
Pallic Soils	Pale colours	NZ Technical Soil Classification*
Podzol Soils	Traditional Russian name referring to the wood ash-like E horizon	NZ Genetic Soil Classification
Pumice Soils	Dominated by pumice	NZ Genetic Soil Classification
Raw Soils	Newly formed	Name new to the NZSC
Recent Soils	Young	NZ Genetic Soil Classification
Semiarid Soils	Semi-arid climate	New name
Ultic Soils	Ultimate soil development	Soil Taxonomy

The NZSC has an hierarchical structure with four levels in the hierarchy

- **Soil orders**
  Soil orders are the highest, most generalised level of the classification and provide the national overview of New Zealand soils. Fifteen soil orders cover the range of New Zealand soils and their distribution is shown in Fig. A1.
  - **Soil groups**
    The orders are divided into 73 soil groups based on variation in factors such as drainage status, parent material, chemical and physical properties.
    - **Subgroups**
      The soil groups are divided into 272 subgroups which provide more detail about the range of soils included in each soil group.
      - **Soilforms**
        The soil subgroups are subdivided into soilforms which provide more detail about the soil parent materials, texture and permeability.

An example of the hierarchy is given in Fig. A2 (p. 233). The number of words making up the name shows the hierarchical level to which a soil has been classified.

How to classify a soil

To find the correct soil class for a soil we examine the soil horizons (or layers) exposed in the side of a freshly dug soil pit, usually to the depth of about 1m (unless rock is found at a shallower depth). We then assign the soil to the correct soil class, by using the keys to orders, groups, subgroups and soilforms in Hewitt (1993) and Clayden and Webb (1994). Lack of space prevents these keys being reproduced here but the simple key in Table 2 provides a guide to the correct order. The keys for assigning a soil to the correct soil class use diagnostic horizons and other defined soil features. Horizon notations provide a shorthand for identifying many of these important features, and some of the more important ones are outlined in Table 3. The correlation of NZSC classes with those used in the NZ Genetic Soil Classification and *Soils in the New Zealand Landscape* is given in Table 4.

TABLE 2.

A simple key for the recognition of soil orders intended to convey the concept of the classes. The key for the recognition of soil orders in Hewitt (1993) should be consulted for an accurate assignment.

Soils dominated by organic material	Organic Soils
Grey colours due to reduction of iron caused by waterlogging beneath a high water table	Gley Soils
Soils disturbed by people	
Made by stripping or mixing the original soil material to depth or by addition of fill.	Anthropic Soils
Minimal soil development	
Soils on young land surfaces where rock material or sediments in which the soil is formed is fresh and little altered.	
No topsoil or minimal topsoil	Raw Soils
With a topsoil	Recent Soils
Intermediate soil development	
Soils where the rock material or sediments in which they are formed are altered but still recognisable, with a large proportion of unaltered minerals. The soils have well-developed subsoil horizons if not on shallow rock.	
Dominated by allophane (from volcanic tephra, weathered sandstone or derivatives)	Allophanic Soils
Dominated by pumice or sandy glassy tephra	Pumice Soils
Dominated by high calcium or magnesium from lime-rich rocks or dark basic volcanic rocks	Melanic Soils
Light coloured rocks or sediments	
Semi-arid climate, rainfall less than about 500 mm/year	Semiarid Soils
Subhumid climate with seasonal drought	Pallic Soils
Humid climate, rarely dry except if sandy or stony where they may be drier	Brown Soils
Super-humid climate	Podzol Soils
Strong soil development	
Soils on old land surfaces where the rock material or sediments in which the soil is formed is mostly transformed to clay.	
Mainly sedimentary rocks	Ultic Soils
Mainly volcanic rocks	
Well-developed polyhedral structure	Granular Soils
Dominated by iron and aluminium oxides	Oxidic Soils

FIG. A2

The hierarchy of the Oxidic Soils is an example of the relationships between orders, groups, subgroups, and soilforms. The range of soil properties for each class is related to hierarchical position.

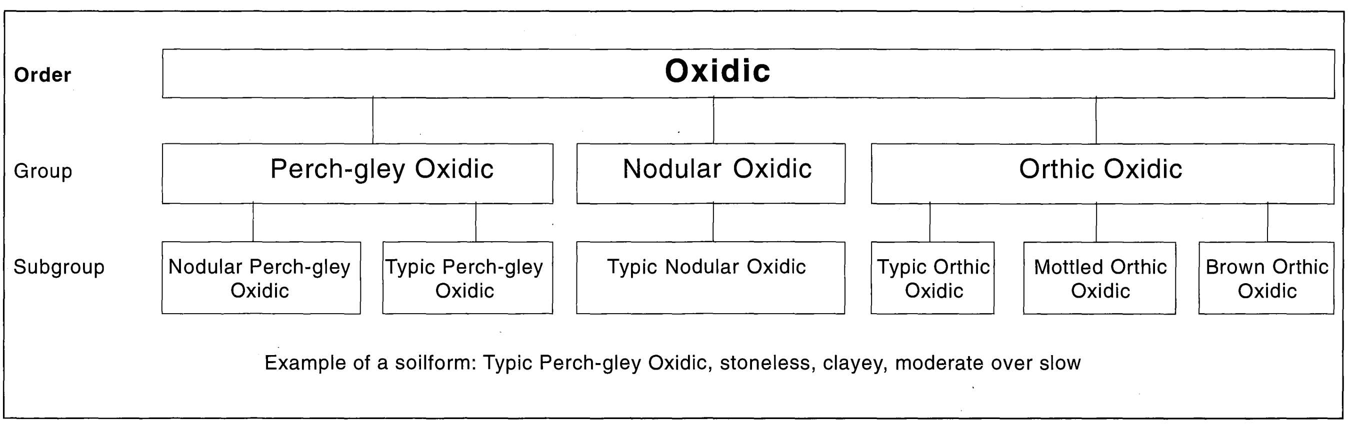


TABLE 3.

Selected horizon notations and related diagnostic horizons of the NZSC. Definitions of the diagnostic horizons or diagnostic features are more restrictive than definitions of horizon notations (for example, thickness limits are imposed on many diagnostic horizons). The relationships shown here are therefore only approximate. Complete lists and definitions of soil horizon notations are given in Milne *et al.* (1995), and diagnostic horizons, soil materials and soil features are given in Hewitt (1993).

Horizon notation	Definition	Related diagnostic horizon or feature
O	Peat, accumulated under wet conditions	Peaty topsoil, organic soil material
A	Mineral horizon (topsoil) formed at the soil surface characterised by incorporation of humified organic matter	
Ah	Topsoil undisturbed by ploughing	Distinct topsoil
Ap	Topsoil disturbed by ploughing	Distinct topsoil
E	Horizon below the H, O, or A horizon that has lost clay, iron or aluminium (eluviated) leaving it relatively pale.	
A/B	Zone of mixing between A and B horizons, frequently caused by worms	
B	A mineral horizon that has been altered by the formation of soil structure, brighter colours (than horizons above or below), or by enrichment in mineral or organic material	
Bw	B horizon, altered by weathering, evidenced by contrast in colour or structure	Weathered -B horizon
Bt	B horizon enriched in clay	Argillic horizon
Bh	Dark B horizon enriched in humus	Podzolic-B horizon
Bs	B horizon enriched in oxides of iron, aluminium with humus	Podzolic-B horizon
Bo	B horizon enriched in kaolin-group clays with iron and aluminium oxides	Oxidic horizon
Bg	B horizon with mottled grey and yellow/orange colours indicative of reduction (gleying)	Mottled profile form, gley profile form, perch-gley features
Br	B horizon with strong reduction due to intense gleying and predominant grey colours.	Gley profile form, perch-gley features
Bk	B horizon enriched in calcium carbonate	Calcareous horizon
BC	Transitional between B and C horizons	
BCx	BC horizon that is compact but not cemented	Fragipan
C	Underlying unconsolidated material, usually showing some weathering but minimal biological activity	
R	Underlying bedrock	Lithic contact

TABLE 4.

General correlation of soil orders of the New Zealand Soil Classification with the New Zealand Genetic Soil Classification (Taylor and Pohlen 1962), and the classes used in *Soils of the New Zealand Landscape*. Correlation with US Soil Taxonomy is given in Hewitt (1993). YB = yellow-brown, BG = brown granular

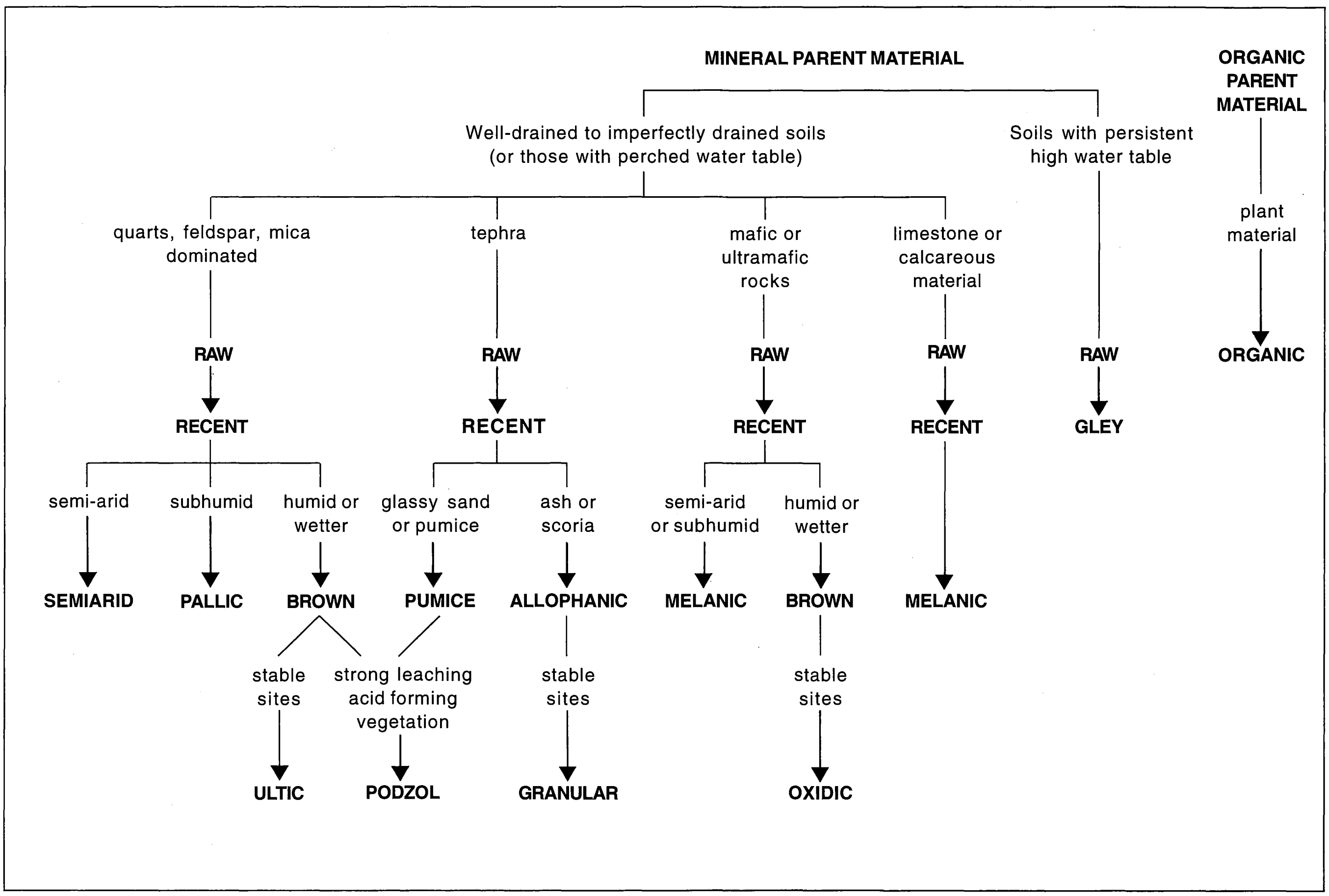
NZ Soil Classification	NZ Genetic Soil Classification	Soils in the New Zealand Landscape
Allophanic Soils	YB loams	volcanic loams
Anthropic Soils	anthropic soils	
Brown Soils loamy	YB earths (but excluding many northern YB earths)	brown earths, coastal sands, volcanic
		clays, stony terrace soils
	BG loams and clays YB shallow and stony soils	
Gley Soils	gley soils or gleyed recent soils	gley soils
Granular Soils	BG loams or BG clays	compact volcanic clays, volcanic loamy clays
Melanic Soils	rendzinas, rendzic intergrades or BG loams and clays	calcareous soils, black swelling clays
Organic Soils	organic soils	organic soils
Oxidic Soils	strongly weathered red loams, brown loams, BG loams or BG clays	friable volcanic clays
Pallic Soils	yellow-grey earths	dense grey earths
Podzol Soils	podzols	podzols
Pumice Soils	YB pumice soils	pumice soils
Raw Soils	unclassified or hydrothermal soils	raw volcanic soils
Recent Soils	recent soils or lithosols	recent alluvial soils, coastal sands
Semiarid Soils	brown-grey earths or solonetz	semiarid soils
Ultic Soils	northern YB earths, YB sands or podzols	brown clays

Formation of New Zealand soils

The soil classification can be used to trace the formation, or evolution, of New Zealand soils through time (Fig. 3). In mineral parent materials Raw Soils develop into Recent Soils. The nature of the parent material then strongly determines the subsequent soil formation pathway. Later, parent material becomes less important, and climate and vegetation become more important controls over the character of the soil that evolves. Soils will only proceed the whole way down a soil formation pathway on relatively stable sites. Erosion or additions of fresh sediment may impede, halt or even reverse soil evolution. Many Raw Soils may never develop into Recent Soils or other soils because they occur in environments with continual cycles of erosion or additions of fresh sediment.

FIG. 3.

Major pathways in the evolution of New Zealand soils. The pathways represent only those likely to have occurred over extensive areas. Other pathways are omitted for clarity. For example, Allophanic Soils may also be formed in quartz, feldspar, mica parent material and Ultic Soils may also be formed in mafic or tephra parent materials.



Description of the soil orders

ALLOPHANIC SOILS

> Soils that have a large affinity for phosphate. Up to 30 tonnes/ha of phosphorus may be locked away in intensely farmed topsoils.

Allophanic Soils are dominated by allophane (and also imogolite or ferrihydrite) minerals. These stiff, jelly-like minerals coat the sand and silt grains and maintain a porous, low-density structure with weak strength. The soils are identified by a distinctly greasy feel when moistened and rubbed firmly between the fingers. The soil is easy to dig and samples crumble easily when crushed in the hand.

OCCURRENCE - These soils occur predominantly in North Island volcanic ash, and in the weathering products of other volcanic rocks. They also occur in the weathering products of greywacke and schist in the South Island high country. They cover 5% of New Zealand.

PHYSICAL PROPERTIES - Because the bulk density is low there is little resistance to root growth. Topsoils are stable and resist the impact of machinery or grazing animals in wet weather. Erosion rates are generally low except on steep slopes or exposed sites.

CHEMICAL PROPERTIES - The ability to retain phosphorus is high. Natural fertility is low.

BIOLOGICAL PROPERTIES - Soils contain large populations of soil organisms, particularly in A horizons.

SOIL GROUPS

Perch-gley Allophanic Soils - periodic wetness caused by a perched water table
Gley Allophanic Soils - periodic wetness caused by a groundwater table
Impeded Allophanic Soils - have a hard layer that impedes roots and water
Orthic Allophanic Soils - other Allophanic Soils

ANTHROPIC SOILS

> New Zealands largest single areas of Anthropic Soils were formed by gold dredging in Central Otago and Westland.

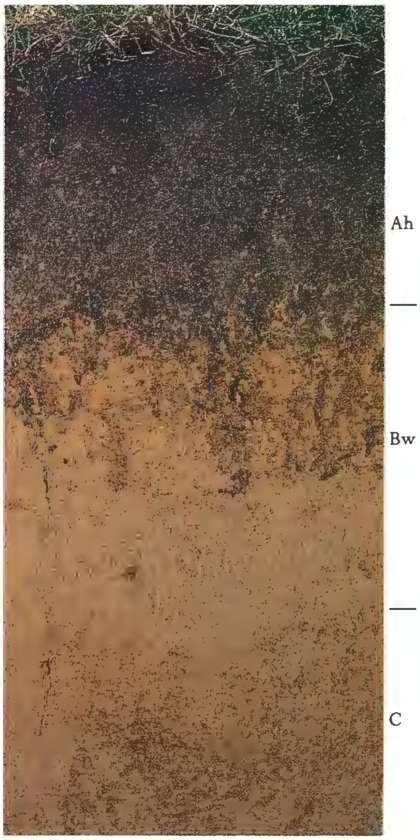
Anthropic Soils are constructed by, or drastically disturbed by people. They include soil materials formed by stripping of the natural soil, deposition of refuse or spoil, or by severe soil mixing. The original character of the soil and the normal soil properties are lost.

OCCURRENCE - Anthropic Soils are most extensive in urban areas and areas that have been mined. They cover <1% of New Zealand.

PHYSICAL, CHEMICAL AND BIOLOGICAL PROPERTIES - The relationships between Anthropic soils and landforms do not have the orderliness of natural soils. Soil properties depend on both the nature of the manufactured or natural materials, and the nature of the soil manipulation. Land surfaces are artificial and drainage has often been changed significantly from the original state.

SOIL GROUPS

Truncated Anthropic Soils - most of the pre-existing soil profile has been removed
Refuse Anthropic Soils - waste material that contains significant organic material
Mixed Anthropic Soils - drastic disturbance and loss of original character by mixing
Fill Anthropic Soils - waste material dominated by inorganic material



BROWN SOILS

> Our most extensive soils, covering 43% of New Zealand.

Brown Soils have a brown or yellow-brown subsoil below a dark grey-brown topsoil. The brown colour is caused by thin coatings of iron oxides weathered from the parent material.

OCCURRENCE - Brown Soils occur in places where summer drought is uncommon and which are not waterlogged in winter. They are the most extensive soils covering 43% of New Zealand.

PHYSICAL PROPERTIES - They have relatively stable topsoils with well developed polyhedral or spheroidal structure.

CHEMICAL PROPERTIES - Soils have low to moderate base saturation. Clay minerals are dominantly mica/illite and vermiculite, with allophane in Allophanic Brown Soils.

BIOLOGICAL PROPERTIES - Soils contain large, active populations of soil organisms, particularly earthworms.

CLIMATE - Rainfall more than 1000 mm/yr. Soils rarely dry except for some stony and sandy soils.

SOIL GROUPS
Allophanic Brown Soils - have an horizon with soil properties dominated by allophanic material
Sandy Brown Soils - dominated by sand or loamy sand to depth
Oxidic Brown Soils - similar to Oxidic Soils but with significant weatherable minerals
Mafic Brown Soils - in materials from dark igneous rocks or sediments
Acid Brown Soils - strongly or extremely acid
Firm Brown Soils - strong, apedal subsurface horizon
Orthic Brown Soils - other Brown Soils

GLEY SOILS

> Gley Soils, together with Organic Soils, represent the original extent of New Zealand wetlands, which have been greatly restricted in area by drainage.

Gley Soils are strongly affected by waterlogging and have been chemically reduced. They have light grey subsoils, usually with reddish brown or brown mottles. The grey colours usually extend to more than 90 cm depth. Waterlogging occurs in winter and spring, and some soils remain wet all year.

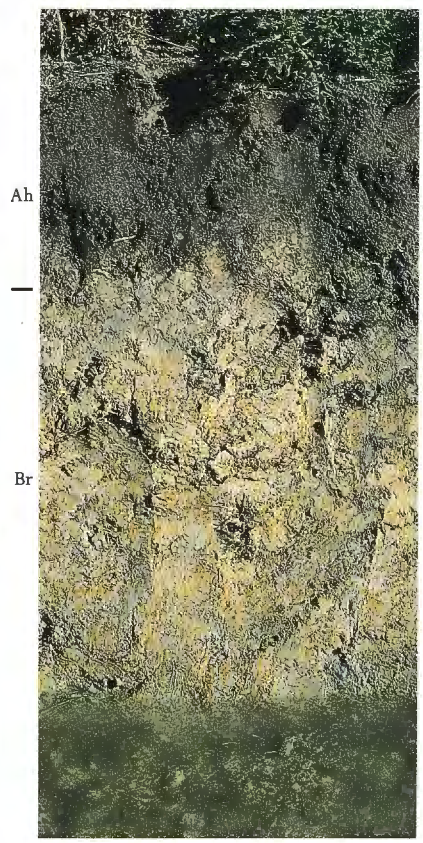
OCCURRENCE - Gley Soils occur throughout New Zealand in low parts of the landscape where there are high groundwater-tables, or in places where there are seepages. Large areas of Gley Soils have been artificially drained to form productive agricultural land. They cover 3% of New Zealand.

PHYSICAL PROPERTIES - These soils have high groundwater-tables, shallow potential rooting depth and relatively high bulk density. Trafficability is limited when soils are wet. Drainage is necessary for most agricultural development.

CHEMICAL PROPERTIES - Soils have common segregated iron and manganese oxide mottles, concretions or nodules. Organic matter content is usually high.

BIOLOGICAL PROPERTIES - Many soil organisms are restricted because of anaerobic conditions.

SOIL GROUPS
Sulphuric Gley Soils - sulphuric acid or the mineral jarosite in marine estuarine soils.
Sandy Gley Soils - dominated by sand or loamy sand to depth
Acid Gley Soils - strongly or extremely acid
Oxidic Gley Soils - similar to Oxidic Soils
Recent Gley Soils - on young land surfaces, mainly alluvial or estuarine
Orthic Gley Soils - other Gley Soils



GRANULAR SOILS

> These highly productive soils have been used continuously for horticulture for up to 40 years at Pukekohe, despite some erosion.

Granular Soils are clayey soils formed from material derived by strong weathering of volcanic rocks or ash. Dry or moist soil samples may be easily parted into small hard fragments. When wetted and rubbed between the fingers the clay becomes sticky and may be easily remoulded with little cracking.

OCCURRENCE - Granular Soils occur only in the northern North Island, particularly in the lowlands of the Waikato and South Auckland regions. Parent materials are usually strongly weathered tephras, mostly older than 50 000 years. They cover 1% of New Zealand.

PHYSICAL PROPERTIES - Polyhedral structure is usually well developed. The soils are slowly permeable and have limited rooting depth. Topsoils have limited workability when wet.

CHEMICAL PROPERTIES - Soils are strongly weathered with low nutrient reserves, and low phosphorus status and sulphate in B horizons. They are usually dominated by kaolin-group clay minerals, with some vermiculite.

SOIL GROUPS
Perch-gley Granular Soils - periodic wetness caused by a perched water table
Melanic Granular Soils - less acid and higher natural fertility than other soil groups
Oxidic Granular Soils - transitional to Oxidic Soils
Orthic Granular Soils - other Granular Soils

MELANIC SOILS

> Perhaps the most naturally fertile soils in New Zealand. They grow high quality pinot noir.

Melanic Soils have black or dark grey topsoils that are well-structured. The subsoil either contains lime, or has well-developed structure and is neutral or only slightly acid.

OCCURRENCE - Melanic Soils occupy small areas scattered throughout New Zealand, in association with lime-rich rocks or dark (basic) volcanic rocks. They cover 1% of New Zealand.

PHYSICAL PROPERTIES - Topsoil structure is usually stable. The soils shrink on drying and swell on wetting.

CHEMICAL PROPERTIES - Natural fertility is high. Base saturation is high with high exchangeable calcium or magnesium. The clay fraction is usually dominated by swelling (smectite) clays.

BIOLOGICAL PROPERTIES - These soils are biologically very active with high populations of soil organisms.

SOIL GROUPS
Vertic Melanic Soils - clayey with high capacity for shrink-swell
Perch-gley Melanic Soils - periodic wetness caused by a perched water table
Rendzic Melanic Soils - limestone or lime rich rock at shallow depth
Mafic Melanic Soils - on dark igneous rocks or sediments
Orthic Melanic Soils - other Melanic Soils

O

ORGANIC SOILS

Serving as giant sponges in the landscape, these soils can hold up to 20 times their weight in water.

Organic Soils are formed in the partly decomposed remains of wetland plants (peat) or forest litter. Some mineral material may be present but the soil is dominated by organic matter.

OCCURRENCE - Organic Soils occur in wetlands in most parts of New Zealand, or under forests that produce acid litter in areas with high precipitation. They cover 1% of New Zealand.

PHYSICAL PROPERTIES - Organic Soils have very low bulk densities, low bearing strength, high shrinkage potential when dried, very low thermal conductivity and high total available-water capacity.

CHEMICAL PROPERTIES - Soils have high cation exchange capacities, are usually strongly or extremely acid, and nutrient deficiencies are common.

BIOLOGICAL PROPERTIES - High carbon/nitrogen ratios indicate slow decomposition rates. Many soil organisms are restricted because of anaerobic conditions.

SOIL GROUPS
Litter Organic Soils - thick litter that has accumulated under forest
Fibric Organic Soils - in peat with plant fibres that are only weakly decomposed
Mesic Organic Soils - in peat that is moderately decomposed
Humic Organic Soils - in peat that is strongly decomposed

OXIDIC SOILS

The first grape vines in New Zealand were probably planted on these soils by an associate of Samuel Marsden at Kerikeri in 1817.

Oxidic Soils are clayey soils that have formed as a result of weathering over extensive periods of time in volcanic ash or dark volcanic rock. Despite high clay contents the soils are friable with low plasticity and fine structure. They contain appreciable amounts of iron and aluminium oxides.

OCCURRENCE - Oxidic Soils are only known in the Auckland and Northland regions. Parent materials are derived from strongly weathered andesite, dolerite or basalt rock or ash. They cover <1% of New Zealand.

PHYSICAL PROPERTIES - Soils have limited rooting depth, well developed and relatively stable structure, slow permeability, and moderate or rapid infiltration rates. Clay contents are high, ranging from 50 to 90%. Soil water deficits are common in summer.

CHEMICAL PROPERTIES - Oxidic soils are strongly weathered with low reserves of potassium, magnesium, calcium and phosphorus. Clays have low cation exchange capacity at the natural pH of the soil, and phosphate retention is high.

SOIL GROUPS
Perch-gley Oxidic Soils - periodic wetness caused by a perched water table
Nodular Oxidic Soils - prominent accumulations of iron oxide
Orthic Oxidic Soil - other Oxidic Soils

Ah

Bo

C


Ah
Bw
Btg
Cx

PALLIC SOILS

A cubic metre of some subsoils can weigh more than 1.8 tonnes.

Pallic Soils have pale coloured subsoils, due to low contents of iron oxides. The soils have weak structure and high density in subsurface horizons. Pallic Soils are dry in summer and wet in winter.

OCCURRENCE - Pallic Soils occur predominantly in the seasonally dry eastern part of the North and South Islands, and in the Manawatu. Parent materials are commonly loess derived from schist or greywacke. They cover 12% of New Zealand.

PHYSICAL PROPERTIES - Soils have slow permeability with limited rooting depth, and medium to high bulk density. They are susceptible to erosion because of high potential for slaking and dispersion.

CHEMICAL PROPERTIES - Soils have medium to high nutrient content (except for sulphur), high base saturation, low concentrations of secondary oxides, and low organic matter contents.

BIOLOGICAL PROPERTIES - Soils are strongly worm-mixed, at the boundary of the A and B horizons.

CLIMATE - Annual precipitation usually between 500 and 1000 mm and the climate is typically droughty in summer, and moist or wet in winter.

SOIL GROUPS

Perch-gley Pallic Soils - periodic wetness caused by a perched water table
Duric Pallic Soils - silica-cemented pan in the subsoil
Fragic Pallic Soils - a compact pan in the subsoil
Laminar Pallic Soils - clay accumulation as thin subsoil bands subsoil
Argillic Pallic Soils - clay accumulation as thin coatings on peds or in pores
Immature Pallic Soils - Weakly expressed pallic soil features

PODZOLS

The impressive contrast in horizons displays the potent effect that particular tree species, for example Kauri, can have on soil formation.

Podzol soils are strongly acid soils that usually have a bleached horizon immediately beneath the topsoil. This horizon is the source of aluminium and iron oxides that have accumulated, in association with organic matter, in an underlying dark or reddish coloured horizon.

OCCURRENCE - Podzol Soils occur in areas of high rainfall and are usually associated with forest trees with an acid litter. The soils occur mainly in materials from silica-rich rocks. They cover 13% of New Zealand.

PHYSICAL PROPERTIES - Cemented or compacted B horizons are common, with associated slow permeability and limited root depth. E and B horizons are weakly pedal or lack pedality.

CHEMICAL PROPERTIES - Podzol soils have low natural fertility, low base saturation, and are strongly acid. Secondary oxides and other clay minerals are strongly differentiated with depth.

BIOLOGICAL PROPERTIES- Podzols have low biological activity. The vegetation comprises plants that deposit a mor-forming acid litter.

CLIMATE - The soils are moist throughout the year with annual rainfall more than about 1500 mm.

SOIL GROUPS

Densipan Podzol Soils - high density, pale coloured, pan just beneath the topsoil
Perch-gley Podzol Soils - periodic wetness caused by a perched water table
Groundwater-gley Podzol Soils - periodic wetness caused by groundwater table
Pan Podzol Soils - with a subsoil cemented pan
Orthic Podzol Soils - other Podzols

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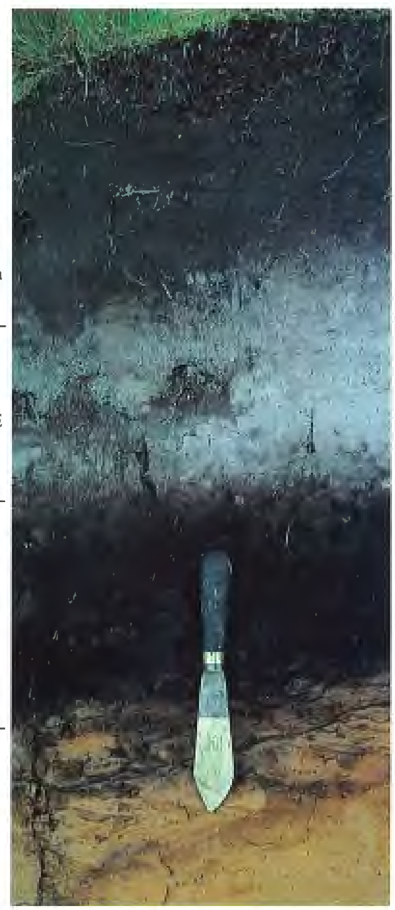

PUMICE SOILS

Mostly derived from one of the greatest volcanic eruptions ever known from the crater now occupied by Lake Taupo.

Pumice Soils are sandy or gravelly soils dominated by pumice, or pumice sand with a high content of natural glass. Drainage of excess water is rapid but the soils are capable of storing large amounts of water for plants. They occur in tephras ranging from 700 to 3500 years old.

OCCURRENCE - Pumice Soils occur predominantly in the central North Island, particularly in the Volcanic Plateau. They cover 7% of New Zealand.

PHYSICAL PROPERTIES - Clay contents are low, generally less than 10%. They have low soil strengths, high macroporosity, and deep rooting depth. Soils have low strength when disturbed, but are generally resistant to livestock treading damage.

CHEMICAL PROPERTIES - The pumice is fresh or only moderately weathered with low reserves of major nutrient elements. Trace elements are likely to be deficient. Clay minerals are dominated by allophane.

BIOLOGICAL PROPERTIES- Soil animal populations are low with most species concentrated in the topsoil. Earthworm populations are limited by droughtiness and coarse texture.

SOIL GROUPS
Perch-gley Pumice Soils - periodic wetness caused by a perched water table
Impeded Pumice Soils - with a subsoil layer that restricts water movement and roots
Orthic Pumice Soil - other Pumice Soils

RAW SOILS

Infant soils that may never grow older because of active erosion or sedimentation.

Raw Soils are very young soils. They lack distinct topsoil development or are fluid at a shallow depth. They occur in environments where the development of topsoils is prevented by rockiness, by active erosion, or deposition.

OCCURRENCE - Raw Soils are scattered throughout New Zealand, particularly in association with high mountains (alpine rock areas and active screes), braided rivers, beaches and tidal estuaries. They cover 3% of New Zealand.

PHYSICAL PROPERTIES - Raw Soils have no B horizon, and a topsoil is either absent or less than 5 cm thick. Most occur in environments with active erosion or deposition. Fluid soils have a continuously high water-table.

CHEMICAL PROPERTIES - Fertility is limited by lack of organic matter and nitrogen deficiency.

BIOLOGICAL PROPERTIES - Vegetation cover is sparse and often consists of ephemeral herbaceous plants, mosses, or lichens.

SOIL GROUPS
Gley Raw Soils - periodically wet
Hydrothermal Raw Soils - soils naturally warmed by geothermal activity
Rocky Raw Soils - rock at shallow depths
Sandy Raw Soils - dominated by sand or loamy sand to depth
Fluvial Raw Soils - in sediments deposited by flowing water
Tephric Raw Soils - in sediments originating as volcanic ejecta
Orthic Raw Soils - other Raw Soils

RECENT SOILS

> The highest recorded carrot production in the world, was from a Recent Soil on the Taieri Plain.

Recent Soils are weakly developed, showing limited signs of soil-forming processes. A distinct topsoil is present but a B horizon is either absent or only weakly expressed.

OCCURRENCE - Recent soils occur throughout New Zealand on young land surfaces, including alluvial floodplains, unstable steep slopes, and slopes mantled by young volcanic ash. Their age varies depending on the environment and soil materials, but most are less than 1000 to 2000 years old. They cover 6% of New Zealand.

PHYSICAL PROPERTIES - The soils have variable soil texture, with common stratification of contrasting materials, and spatial variability is high. They are generally deep rooting and have high plant-available water capacity.

CHEMICAL PROPERTIES - Natural fertility is usually high with high base saturation. The clay mineralogy is usually dominated by illite.

BIOLOGICAL PROPERTIES - A continuous cover of vascular plants is normally well established.

SOIL GROUPS
Hydrothermal Recent Soils - soils naturally warmed by geothermal activity
Rocky Recent Soils - rock at shallow depths
Sandy Recent Soils - dominated by sand or loamy sand to depth
Fluvial Recent Soils - in sediments deposited by flowing water
Tephric Recent Soils - in sediments originating as volcanic ejecta
Orthic Recent Soils - other Recent Soils, most commonly on slopes

SEMIARID SOILS

> Great soils for rabbits with densities of more than 800 rabbits per square kilometre during plagues.

Semiarid Soils are dry for most of the growing season. Rain is not sufficient to leach through the soil, so that lime and salts accumulate in the lower subsoil. Nutrient levels are relatively high, but the soils must be irrigated to produce a crop.

OCCURRENCE - Semiarid Soils occur in the inland basins of Otago and southern Canterbury, where annual precipitation is less than about 500 mm. They cover 1% of New Zealand.

PHYSICAL PROPERTIES - Soils have high slaking and dispersion potential, and moderate to high bulk densities. Soil structure is usually weakly developed and the soils are erodible.

CHEMICAL PROPERTIES - The soils have low organic matter, cation exchange capacity and low iron and aluminium oxide contents. They are weakly buffered. Soluble salts are present in many soils, calcium carbonate is present in most subsoils. Clay minerals are dominated by illite.

BIOLOGICAL PROPERTIES - Soils have low biological activity because of droughtiness and low organic matter contents.

CLIMATE - Annual precipitation ranges from about 350 to 500 mm.

SOIL GROUPS
Aged-argillic Semiarid Soils - reddish coloured clay accumulations
Solonetzic Semiarid Soils - relatively high amount of sodium on clay surfaces
Argillic Semiarid Soils - clay accumulation as thin coatings on peds or in pores
Immature Semiarid Soils - features are weakly expressed

ULTIC SOILS

Probably the first New Zealand soil to be cultivated by steel implements, by men under the command of Marion du Fresne in 1771 in the Bay of Islands.

Ultic Soils are strongly weathered soils that have a well-structured, clay-enriched subsoil horizon. An E horizon, which is relatively depleted in clay, frequently occurs immediately beneath the topsoil. The soils are acid and strongly leached, with generally low levels of calcium and other basic cations. They occur in clay or sandy clay material derived by strong alteration of quartz-rich rocks over long periods of time.

OCCURRENCE - Ultic Soils are most common in the northern North Island, and the Wellington, Marlborough, and Nelson regions. They cover 3% of New Zealand.

PHYSICAL PROPERTIES - Clayey subsoils with slow permeability are characteristic. Soils have dispersible surface horizons susceptible to livestock treading damage, and are prone to erosion.

CHEMICAL PROPERTIES - Soils are strongly acid with low nutrient reserves. There is a small content of weatherable minerals. Kaolin and vermiculite are the dominant clay minerals.

BIOLOGICAL PROPERTIES - Soils have a large and active population of soil organisms in topsoils.

SOIL GROUPS

Densipan Ultic Soils - high density, pale coloured, uncemented pan just beneath the topsoil
Albic Ultic Soils - pale coloured horizon just beneath the topsoil
Perch-gley Ultic Soils - periodic wetness caused by a perched water table
Sandy Ultic Soils - occur in weathered sands
Yellow Ultic Soils - yellow or yellow-brown colours in the subsoil