NEW ZEALAND

SOIL

CLASSIFICATION

A.E. Hewitt

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## FOREWORD

Many technical terms are used throughout this report in the keys and definitions. These technical terms, printed here in italics, are defined in this book in the section “Diagnostic Horizons and other Differentiae” and the glossary.

Further details and technical terms are defined in other resources:

* *Horizon notations* were originally based on Clayden and Hewitt (2015) and previous versions, also recently updated in Milne *et al.* (1995).
* *Soil morphology* terms are defined by Milne *et al.* (1995).
* C*lasses of the US Soil Taxonomy* are defined by Soil Survey Staff (1999, 2022.
* S*oil colours* are defined by Pantone (2017) (see also Bigham and Ciolkosz, 1993).
* S*oil mineralogy classes* are defined by Whitton and Childs (1989) or Childs and Whitton (1990). Note that the soil mineralogy class names given here are based on the following control section: 25 cm to 100 cm or to a lithic or paralithic contact if shallower.
* S*oil chemical terms* are explained and the analytical methods are described by Blakemore *et al.* (1987). Note that soil pH measurements are made in water with a ratio of 1 part of soil to 2.5 parts of water, by weight.
* S*oil physical terms* are explained and the analytical methods are described by Gradwell and Birrell (1979) and McQueen (1993).
* A comprehensive overview of the diversity of soils and landscapes in Aotearoa New Zealand is given by Hewitt et al. (2021).
* Many other soil science concepts and technical terms are explained, in a New Zealand context, by McLaren and Cameron (1990).

## INTRODUCTION

Version 4.0 of the Zealand Soil Classification is the culmination of a period of development from its initiation in 1983 to wide circulation of versions 1.0 through to 3.0 for comment and testing. It represents the best attempt, given the current state of knowledge, to classify New Zealand soils. As the knowledge and understanding of New Zealand soils grows, further revisions will be necessary.

The New Zealand Soil Classification is a national soil classification intended to replace the New Zealand Genetic Soil Classification (Taylor 1948; Taylor and Cox 1956; Taylor and Pohlen 1962). The New Zealand Genetic Soil Classification grew out of the need for reconnaissance mapping of the nation’s soil resources. It was successful as a unifying factor in New Zealand soil science, and it played a vital role in the development of pastoral agriculture. However, modern soil surveys and land evaluations required precise definition of classes and keys for their recognition. Furthermore, a new synthesis was needed of the large body of information collected since the 1950s. The present work has grown out of the New Zealand Genetic Soil Classification and, where possible, preserves successful parts of that classification. It has also been influenced by experience in testing the US Soil Taxonomy (Leamy *et al.* 1983).

### OBJECTIVES

The objectives of the New Zealand Soil Classification are:

1. to provide a better means of communication about New Zealand soils and their utilisation;
2. to provide an efficient vehicle for soil type identification, and correlation, and soil map legend establishment in soil surveys;
3. to enable an efficient stratification of soil database information;
4. to draw together knowledge of the properties of New Zealand soils and important similarities and differences among them.

A discussion of these objectives is given by Hewitt (1984).

### PRINCIPLES

To accomplish the objectives, the following principles have guided the development of this proposal. These are explained further by Hewitt (1984).

1. The classification should be hierarchical, providing ascending levels of generalisation.
2. The grouping of soils into classes should be based on similarity of measurable soil properties rather than presumed genesis.
3. Classes must be designed to allow the greatest number and most precise accessory statements to be made about them consistent with their level in the hierarchy.
4. Differentia should be based on soil properties that can be reproducibly and precisely measured or observed.
5. Differentia should where possible allow field assignment of soils to classes, either directly, or by tested inferences.
6. The nomenclature of higher categories should be based where possible on connotative English words chosen for their acceptability to nonspecialists.
7. Where possible, continuity with successful parts of the New Zealand Genetic Classification should be maintained.
8. The soil classification must be valid for the main islands of New Zealand. Classes must be correlated with Soil Taxonomy (Soil Survey Staff 1999) to support international extension.

### THE SOIL INDIVIDUAL

The soil individual is the fundamental unit of soil which is assigned to classes. Cline (1949) defined an individual as “the smallest natural body that can be defined as a thing complete in itself”.

Soil Taxonomy (Soil Survey Staff 1975) regards the polypedon as the soil individual. This is rejected here because, as discussed by Hewitt (1982), it does not fulfil Cline’s (1949) or Johnson’s (1963) requirements for a soil individual.

In New Zealand, the soil individual has traditionally been the soil profile. Usually conceived as a two-dimensional section exposed by a soil pit, it is in fact a three-dimensional slice sufficiently thick to sample and examine hand specimens. It should therefore be termed a “soil profile slice”. With the realisation that soils should be examined in successive horizonal sections as well as the vertical profile, there is increasing acceptance that a volume of soil the size of the pedon (Soil Survey Staff 1975) represents a better soil individual than the soil profile slice.

Accordingly, the pedon as defined in Soil Taxonomy (Soil Survey Staff 1975) is recommended as the soil individual for the New Zealand Soil Classification. It is understood that assignments are often made from the examination of volumes of soil smaller than a complete pedon, where they are assumed representative of the pedon.

### HOW TO ASSIGN A SOIL TO SUBGROUP LEVEL

Normally, a soil pit must be dug of sufficient size to expose the soil horizons to about 1 m depth, or to rock if shallower.

The soil horizons are examined and the assignment is then made by following the key, starting with the key to orders on page 35. The “Diagnostic Horizons and Other Differentiae” section is consulted as necessary to identify diagnostic horizons and other differentia. For some classes, pH or other chemical measurements must be made. These should be performed on samples taken between the specified depths, and bulked from at least four places in the pit. The characteristics of the soil are compared with the key statements of each soil order, starting with Organic Soils and passing down the key to the first

Order

Group

Subgroup

OXIDIC SO

ILS

PERCH-GLEY

NOD

ULAR

OR

THIC

TYPIC

NODULAR

TYPIC

MOTTLED

BROWN

TYPIC

***Figure 1.*** *The hierarchy of the Oxidic Soils as an example of the hierarchical relationships between orders, groups and subgroups. As the diagram suggests, the range of soil properties for each class is related to hierarchical position.*

soil order that fits them. When a soil order is identified, the chapter concerning that order is consulted and the keys to soil groups and soil subgroups are followed in the same manner to identify the appropriate soil group and subgroup.

The name given to a soil assigned to a subgroup is made up of three elements in the sequence: subgroup, group, and order (for example, Nodular Perch-gley Oxidic Soils). Figure 1 illustrates the relationships between subgroups and groups in the Oxidic Soils order.

### MISCLASSIFICATION

The classes are the most important part of the soil classification. The key is merely a means of allocating soils to these classes, and by its nature is imperfect because only a sample of all the possible soils that might potentially be allocated were used in developing the key. Consequently, soils will be found that are not allocated to the appropriate class by the key. This will be apparent when a soil, allocated to a class, does not conform to the concept and accessory statements that can normally be made about that class. Because the key is the servant of the classes, the allocator is justified in placing the soil misfit into a more appropriate class. If this is done, however, it must be registered with the person with responsibility for the national soil classification system, so that appropriate adjustments may be made to the key when the soil classification is next revised. An allocation contrary to the key must also be noted in any records or publication of the allocation.

### JUSTIFICATION OF NEW SUBGROUPS

Justification for new subgroups may be made in two ways. First, if a soil is judged to be misclassified, and a more appropriate class is not available, then a new subgroup may be justifiable. Second, an existing subgroup may encompass a set of soils with properties that are too wide in range. The old subgroup could be split into two new ones. Splitting may be justified if it will significantly increase the number and precision of accessory statements that can be made about both of the new classes.

### CORRELATIONS WITH OTHER SOIL CLASSIFICATION SYSTEMS

Classes of the New Zealand Soil Classification do not correspond precisely with classes of other soil classification systems. Despite this, correlations can be made where classes are substantially equivalent. Table 1 summarises the correlations of classes of the Zealand Soil Classification with those of the New Zealand Genetic Soil Classification (Taylor and Pohlen 1962) and Soil Taxonomy (Soil Survey Staff 1999, 2022), where the reader can also find more information about the technical terms used in the correlation.

**Table 1.**

**Correlation of soil groups with the Genetic New**  **Zealand Soil**   **Classification**  **(Taylor and Pohlen**  **1962)**

**And the US**  **Soil Taxonomy**  **(Soil Survey Staff 1999). The**  **correlations**  **with**   **Soil Taxonomy provide only**

**the**  **nearest**  **equivalents,**  **as criteria differ**  **between**  **the**  **two**  **systems.**   **The**  **lowest category of Soil Taxonomy**

**is given (order,**  **suborder**  **or**  **great**  **group)**  **that can**  **be**  **best related to soil groups of the NZ Soil Classifica-**

**tion.**

**NZ**  **Soil Classification**

**NZ**  **Genetic**  **Soil**

**(version 3)**

**Classification**

ALLOPHANIC SOILS

Perch-gley Allophanic Soils

gley soils

Aquands

Gley Allophanic Soils

gley soils

Aquands

Impeded Allophanic Soils

YB\*loams

Cryands and Udands

Orthic A llophanic Soils

YB loams

Cryands and Udands

ANTHROPIC SOILS

Truncated Anthropic Soils

anthropic soils

Arents

Refuse Anthropic Soils

anthropic soils

Arents or unclassified

Mixed Anthropic Soils

anthropic soils

Arents

Fill Anthropic Soils

anthropic soils

Arents

**Soil**  **Taxonomy**

\* YB = yellow-brown

**Table 1.**

*(continued)*

**NZ**  **Soil Classification**

**NZ Genetic Soil**

**(version 3)**

**Classification**

BROWN SOILS

Allophanic Brown Soils

YB earths (upland & high country)

Dystrudepts

Sandy Brown Soils

YB sands

Dystrustepts, Dystrudepts and Psamments

Oxidic Brown Soils

YB earths (northern)

Dystrudepts

Mafic Brown Soils

BG\* loams and clays

Dystrudepts

Acid Brown Soils

podzolised YB earths or YB earths

Dystrudepts

Firm Brown Soils

YB earths, YB shallow and stony soils

Dystrudepts and Dystrustepts

Orthic Brown Soils

YB earths, YB shallow and stony soils

Dystrudepts and Dystrustepts

GLEY SOILS

Sulphuric Gley Soils

gley soils

Sulphaquepts

Sandy Gley Soils

gley soils

Aquepts or Aquents

Acid Gley Soils

gley soils

Aquepts

Oxidic Gley Soils

gley soils

Aquox

Recent Gley Soils

Gleyed recent soils

Aquents

Orthic Gley Soils

gleyed recent soils

Aquepts or Aquents

**Soil**  **Taxonomy**

\* BG = brown granular

**Table 1.**

*(continued)*

**NZ**  **Soil Classification**

**NZ Genetic Soil**

**(version 3)**

**Classification**

GRANULAR SOILS

Perch-gley Granular Soils

BG loams or BG clays

Aquults

Melanic Granular Soils

BG loams or BG clays

Humults and Udalfs

Oxidic Granular Soils

BG loams or BG clays

Humults

Orthic Granular Soils

BG loams or BG clays

Humults

MELANIC SOILS

Vertic Melanic Soils

BG loams and clays

Ustolls or Vertisols

Perch-gley Melanic Soils

gley soils

Aquolls

Rendzic Melanic Soils

rendzinas

Rendolls

Mafic Melanic Soils

BG loams and clays

Haplustepts, Ustolls or Udolls

Orthic Melanic Soils

Rendzinas and rendzic intergrades

Ustolls, Udolls, Haplustepts or Calciustepts

ORGANIC SOILS

Litter Organic Soils

unclassified

Folists or unrecognised

Fibric Organic Soils

organic soils

Fibrists

Mesic Organic Soils

organic soils

Hemists

Humic Organic Soils

organic soils

Saprists

**Soil**  **Taxonomy**

**Table**  **1.**

*(continued)*

**NZ**  **Soil Classification**

**NZ**  **Genetic**  **Soil**

**(version**  **3)**

**(**

**Classification**

OXIDIC SOILS

Perch-gley Oxidic Soils

gley soils

Aquox

Nodular Oxidic Soils

}

strongly weathered red loams,

Udox

Orthic Oxidic Soils

brown loams, or BG loams or BG clays

Udox

PALLIC SOILS

Perch-gley Pallic Soils

yellow-grey earths

Aquepts, Aqualfs

Duric Pallic Soils

yellow-grey earths

Duraqualfs

Fragic Pallic Soils

yellow-grey earths

Fragiudalfs, Fragiochrepts

Laminar Pallic Soils

yellow-grey earths

Haplustalfs, Hapludalfs

Argillic Pallic Soils

yellow-grey earths

Haplustalfs, Hapludalfs

Immature Pallic Soils

yellow-grey earths or recent soils

Haplustepts

PODZOLS

Densipan Podzols

podzols

Aquods, Orthods

Perch-gley Podzols

gley podzols

Aquods

Groundwater-gley Podzols

gley podzols

Aquods

Pan Podzols

podzols

Orthods

Orthic Podzols

podzols

Orthods

**Soil Taxonomy**

**Table 1.**

*(continued)*

**NZ**  **Soil Classification**

**NZ Genetic Soil**

**(version 3)**

**Classification**

PUMICE SOILS

Perch-gley Pumice Soils

gley soils

Vitraquands

Impeded Pumice Soils

YB pumice soils

Vitrands, Vitricryands

Orthic Pumice Soils

YB pumice soils

Vitrands, Vitricryands

RAW SOILS

Gley Raw Soils

unclassified

Entisols or not-soil

Hydrothermal Raw Soils

Hydrothermal soils

Entisols or not-soil

Rocky Raw Soils

unclassified

Entisols or not-soil

Sandy Raw Soils

unclassified

Entisols or not-soil

Fluvial Raw Soils

unclassified

Entisols or not-soil

Tephric Raw Soils

unclassified

Entisols or not-soil

Orthic Raw Soils

unclassified

Entisols or not-soil

RECENT SOILS

Hydrothermal Recent Soils

recent soils

Aquents, Orthents

Rocky Recent Soils

lithosols

Orthents

Sandy Recent Soils

recent soils

Psamments

Fluvial Recent Soils

recent soils

Fluvents, Udepts, Ustepts

Tephric Recent Soils

recent soils

Orthents, Cryands, Udands

Orthic Recent Soils

Recent soils

Orthents, Udepts, Ustepts

**Soil Taxonomy**

**Table 1.**

*(continued)*

**NZ Soil Classification**

**NZ Genetic Soil**

**(version 3)**

**Classification**

SEMIARID SOILS

Aged-argillic Semiarid Soils

brown-grey earths

Haplargids

Solonetzic Semiarid Soils

solonetz

Natragids

Argillic Semiarid Soils

brown-grey earths

Haplargids

Immature Semiarid Soils

brown-grey earths

Haplocambids, Aquicambids

ULTIC SOILS

Densipan Ultic Soils

YB earths or podzols

Aquults

Albic Ultic Soils

YB earths

Aquults, Humults or Udults

Perch-gley Ultic Soils

YB earths

Aquults

Sandy Ultic Soils

YB earths or YB sands

Hapludults

Yellow Ultic Soils

YB earths

Hapludults

**Soil Taxonomy**

# DIAGNOSTIC HORIZONS AND OTHER DIFFERENTIAE

Diagnostic horizons and other differentiating criteria are defined to facilitate the assignment of soils to classes. The definitions are not intended to represent a comprehensive classification of horizons. A summary of these is given in Table 2. Transitional horizons (e.g. AB or A/B horizons) are not included when considering horizon notations for NZSC criteria unless explicitly stated. Note that:

* “in some part” means that the requirement must be met in some subhorizon or some subsample that is 10 cm or more thick within the specified thickness.
* “in the major part” means that the requirement must be met over more than half the specified thickness (in this case from the base of the A horizon to 60 cm from the mineral soil surface). Analyses or estimates should be used from subhorizons that subdivide the thickness, or if the subhorizons are not recognised, then from subsamples of the relevant horizons.

**Table 2. Summary of diagnostic horizons and other differentiae.**

|  |  |
| --- | --- |
| **Horizons, Pans and Layers:**  Argillic horizon  Brittle-B horizon  Calcareous horizon  Cutanic horizon  Cutanoxidic horizon  Densipan  Duripan  Distinct topsoil  Eluvial horizon  Fragipan  Humus-pan  Ironstone-pan  Nodular horizon  Ortstein-pan  Oxidic horizon  Peaty topsoil  Placic horizon  Podzolic-B horizon  Reductimorphic horizon  Redox-mottled horizon  Slowly permeable layer  Weathered-B horizon | **Soil Materials and Contacts:**  Anthropic soil material  Allophanic soil material  Lithic contact  Organic soil material  Paralithic contact  Tephric soil material Vitric soil material  **Profile Forms:**  Gley profile form  Mottled profile form  **Features:**  Fluvial features  Perch-gley features Sodic features  **Other Differentiae:**  Crumb structure  Reactive-aluminium test  Redox segregations |

The following diagnostic horizons and soil characteristics have been modified from Soil Taxonomy (Soil Survey Staff 1975): argillic horizon, duripan, fragipan, lithic contact, paralithic contact and placic horizon.

### Allophanic soil material

Allophanic soil material has soil properties dominated by minerals with short-range order, especially allophane, imogolite and ferrihydrite. Other terms such as “amorphous”, “poorly crystalline” and “non-crystalline”, have been, or are, sometimes used for such minerals. Their chief characteristics are reactive variable-charge surfaces, and a very high specific surface area (several hundreds of m2/g). Allophanic soil material has **both**

1. ***Either***

(a) All of the following (in a fresh sample):

1. Sensitive or strongly sensitive sensitivity class (distinctly greasy or smeary feel except in some sandy soils), *and*
2. Very weak or weak unconfined soil strength class (when moist), *and*
3. Non-sticky or slightly sticky stickiness class, *and* (iv) Strong or very strong reactive-aluminium test.

***or***

(b) P retention of 85% or more;

**AND**

2. Dry bulk density of the fine-earth fraction (where the volume is determined on a field-moist soil) of less than 0.9 Mg/m3.

Layers meeting the requirements of allophanic soil material may also meet the requirements of vitric soil material.

Accessory chemical properties relate to variable-charge characteristics, P retention, and high organic-matter contents. Accessory physical properties include high total available water capacity and readily available water capacity, and low penetration resistance. In addition, allophanic soil material undergoes irreversible changes upon drying, for example, in plastic and liquid limits and in apparent particle-size distribution. It should be noted that minerals other than allophane (e.g. ferrihydrite) can give rise to allophanic soil material.

### Anthropic soil material

Anthropic material constitutes human-altered or human-transported soil material that shows evidence of the purposeful modification of soil properties or of surface features by human activity. The field evidence of alteration excludes low impact agricultural practices such as shallow cultivation, digging, ploughing, or the addition of amendments. Artificially drained soils/wetlands are also not included here because it is difficult to unambiguously link artificial drainage to specific, field-identifiable soil indicators. The nature of alteration can comprise profile truncation, mixing, deposition of transported material, and addition of artefacts. Due to the high variability of the morphological or chemical soil properties that can result from human soil modifications, the criteria of anthropic material are mainly linked to their anthropic genesis, and thus deviate from the principles of the NZSC. Common indicators of anthropic material in New Zealand are:

• excavated or constructed landforms,

• mechanically detached, redistributed, and re-oriented soil material,

• mechanically abraded and broken rock fragments that do not correspond with the fragments in the underlying soil material (e.g., fractures that cut through rather than between individual minerals),

• manufactured materials, such as charcoal, and artefacts,

• relocated soil material overlying bones, shells or manufactured materials,

• eating and cooking waste and associated charred products,

• waste products of manufacturing processes.

The relationship between natural soil horizons or parent materials with anthropic material or truncation is commonly in the form of a lithological discontinuity, indicated by abrupt or sharp transitions between horizons. The majority of anthropic material (including truncation) in NZ is the result of distinct and extensive modification from the mid-19th century coinciding with early European settlement, deforestation, and farming. From the mid-20th century, excavation and construction (e.g., infrastructure, roading, industrial and urban expansion) has increasingly intensified these impacts on our soils. The influence of ‘older’ Māori cultural practice (e.g., soil alteration/modification practices, Māori plaggen soils) is still recognised in many parts of NZ, and can predate European settlement. Distinct soil management alterations from historical (dating back to early Polynesian settlement) to modern times can be distinguished at the group or family level.

### Argillic horizon

An argillic horizon is a clay-enriched horizon. It is indicated by a “Bt” horizon notation as in Btg, BCt, etc. It has **ONE** of the following:

1. It is vertically continuous and is 10 cm or more thick. Clay coatings occur that have a waxy lustre when dry and sufficient thickness to envelop fine sand grains. Coatings occur either on peds (10% or more of the ped surfaces), or in pores (in more than one-third of the observed tubular pores) or as bridges between sand grains (in more than half of the horizon); **OR**
2. It is composed of clay-enriched lamellae (clay bands), that within 90 cm of the mineral soil surface have a combined thickness of 15 cm or more; **OR**
3. It contains sufficiently more clay than the overlying horizon, as detected by hand texturing (5% or more), excluding any differences which result from a lithological discontinuity, and **either**
4. it is overlain by an eluvial horizon (Ew or Eg) and the upper boundary of texture contrast is abrupt or sharp, **or**
5. clay coatings occur on ped or pore surfaces.

Horizons having coatings which do not meet the requirements of an argillic horizon are likely to meet the requirements of a cutanic horizon.

### Brittle-B horizon

A brittle-B horizon is a B or BC horizon that has **all** of the following:

1. Brittle failure (the horizon may contain rock fragments, but the fine-earth fraction must be sufficiently coherent to allow brittle failure);

**AND**

1. It is apedal-massive. Extremely coarse or gross prisms may be present, if the interior of the prisms is apedal-massive; **AND**
2. Few or less fine roots occur throughout the horizon.

The brittle-B horizon differs from the fragipan by having either lower soil strength or lower penetration resistance. Extremely coarse prism faces, if present, are not defined by low chroma colours as they are in a fragipan. The horizon commonly has some roots throughout, in contrast to the fragipan in which roots are confined to cracks. A brittle-B horizon is usually given the horizon notation suffix (x).

### Calcareous horizon

A calcareous horizon is a horizon in which calcium carbonate occurs in the fine-earth fraction. The concentration may be as low as 1%, but its presence can be detected by effervescent reaction with 10% HCl on samples from a freshly exposed profile. The calcium carbonate may be inherited from a calcareous parent material (‘primary’ carbonates), or it may be formed in the soil and occur as coatings on stones, thread-like deposits in pores, or as nodules (‘secondary’ carbonates). A calcareous horizon is given the horizon notation suffix k.

### Crumb structure

Crumb structure is defined as an earthy apedal material (Milne *et al*. 1991) with very friable failure class. Soil with crumb structure in situ has the gross appearance of massive soil material, but when disaggregated or disturbed, microfragments are produced with a superficial resemblance to breadcrumbs. When examined with a ×10 power hand-lens, these prove to be loosely packed aggregates of spheroidal micropeds (< 0.5 mm) with packing voids forming a prominent part of the aggregate.

### Cutanic horizon

A cutanic horizon is a B or BC horizon containing translocated material forming dark-coloured coatings on ped faces, in pores or on coarse fragments. The coatings fail to meet the requirements for coatings of an argillic horizon or a Bh horizon.

It meets **BOTH** of the following:

1. The coatings do not have a waxy lustre when dry or are not sufficiently thick to envelop fine sand grains. Silt coatings are excluded. (Silt coatings have similar colour to the matrix, or have higher value and/or lower chroma than the matrix. On drying they may be thick enough to meet argillic horizon requirements, and have flow-like surfaces, but they have a matt rather than a waxy lustre.) **AND**
2. The coatings have moist colour values of 4 or less, or value 5 and chroma 3 or less.

Many soils have horizons with coatings on peds or in pores which are very thin, do not have a waxy lustre when dry and have lower colour value than the matrix. It is difficult in the field to decide whether these coatings are inorganic or organic, and whether they are derived by illuviation from overlying horizons, by movement within horizons or by in-situ weathering. The cutanic horizon is designed to recognise such horizons. A cutanic horizon is usually given the horizon notation suffix (h).

### Cutanoxidic horizon

A cutanoxidic horizon (Wilson 1987) is a strongly weathered, clayey, low-activity-clay horizon. The dominant clays are kaolin group minerals, and clay coatings occur on less than 10% of ped faces. Exchangeable aluminium, as a percentage of CEC, is usually greater than 25% (and is frequently more than 50% in some part of the horizon)., It has **all** the following characteristics:

1. It meets the requirements of a cutanic horizon; **AND**
2. It is a B horizon that is clayey and has fine polyhedral peds; **AND**
3. Soil materials lack the characteristic friable failure over a wide range in moisture contents that is exhibited by oxidic horizons. It has a failure class of friable only at water contents close to field capacity. Small changes in water content from field capacity result in large changes in soil strength and failure. Semi-deformable failure occurs at water contents wetter than field capacity. Very firm or stronger ped strength with brittle failure occurs at soil water matric potentials drier than about 30 kPa.; **AND**
4. Soil materials are sticky and very plastic, in comparison to oxidic materials which are only slightly sticky in relation to their clay content; **AND**
5. Peds are larger than 2 mm and have smooth faces with silt-sized aggregates of iron oxides, which give the ped faces a dusty appearance when dry. The latter property in particular distinguishes this horizon from horizons developed in well-drained Brown Soils.

The significance of this horizon lies in the combination of low ECEC, clay illuviation, acidity and physical properties different to that of oxidic horizons.

### Densipan

A densipan is a non-cemented E horizon, denoted with the suffix d, of very high soil strength and bulk density. It meets all of the the following requirements:

1. It is an eluvial horizon;

**AND**

1. ***Either***

(a) Unconfined strength is hard or very hard at soil water states from near wet to dry,

***or***

(b) Soil penetration resistance exceeds 4000 kPa at soil water states from near wet to dry;

**AND**

1. Moist and dry samples slake in water.

Densipans occur in soils with felsic parent materials. The strength is due to a close-fit arrangement of sand and silt-sized quartz particles. It differs from a duripan by lack of cementation.

### Distinct topsoil

A distinct topsoil (modified from Avery 1980) is normally designated an A horizon and has **BOTH** of the following:

1. Moist colour value and/or chroma is less than that of the horizon below; **AND**
2. Thickness is 5 cm or more (including any F, H or O topsoil layer).

The distinct topsoil is used to distinguish minimal soil development in the distinction between Recent Soils and Raw Soils.

### Duripan

A duripan is a subsurface horizon that is cemented by silica or other opaque or uncoloured material. It has **ALL** of the following requirements, but does **not** meet the requirements of the calcareous horizon:

1. Dry fragments do not slake in water even during prolonged wetting; **AND**
2. It does not react visibly with 10% HCl; **AND**
3. The average lateral distance between any fractures is 100 mm or more.

The duripan is recognised in Pallic Soils where the cementing materials are apparently related to the presence of tephra in the parent material or high exchangeable sodium in the soil. A duripan is given the horizon notation suffix q.

### Eluvial horizon

1. An eluvial horizon is a mineral horizon with the horizon notation E that, as a result of downward or lateral movement, contains less organic matter, pedogenic oxides, clay, or a combination of these than the horizon immediately below. Relative to an overlying H, O or A horizon, it contains less organic matter. The colour of the horizon can be that of uncoated sand and silt grains but E horizons are also recognised where coats of iron oxides or other minerals mask the colour of the primary particles. It has **all** the following characteristics:A moist colour value of 4 or more, or a dry colour value of 5 or more, with or without skeletans; **AND**
2. ***Both***
3. A higher colour value or lower chroma combined with less well developed pedality or coarser texture than an underlying B horizon; **AND**
4. A higher colour value than an overlying H, O or A horizon.

### Fluvial features

The intention of the term ‘fluvial features’ is to recognise soils with parent materials that result from transportation, sorting and deposition by water. Fluvial features are used to differentiate Recent Soils, Raw Soils and parent material classes of soil series that occur on landforms formed through fluvial processes.

Relevant landforms include floodplains, estuarine surfaces, lacustrine surfaces, aggregating fan surfaces, levees, backplains, bars, channels, deltas, floodplain benches, outwash plains and swamps (all defined by Milne *et al*. 1991).

Confirming soil characteristics include:

1. A buried A horizon or some other field indication of an irregular change in carbon with depth (such as sedimentary plant-leaf material).
2. Sedimentary bedding in C (or transitional C) horizons, indicating deposition in water (such as scoured surfaces, cross-stratification, sedimentary laminations, current ripples or foreset beds).
3. A horizon with moderately fluid, or very fluid, fluidity class in some layer with an upper surface within 120 cm of the soil surface, indicating lack of pedogenic development.
4. In tephric soil materials
   1. disturbance or overthickening of the regional sequence of tephras;
   2. rounded or subrounded coarse rock fragments;
   3. presence of non-volcanic rock fragments.

The emphasis here on genetic landform criteria is not consistent with the principle that soils should be classified on the basis of similarity of measurable soil properties rather than presumed genesis (see Introduction). Measurable soil properties that will group together the required soils have not been recognised. The confirmatory soil properties, however, will aid class assignment decisions in many cases.

### Fragipan

A fragipan is a non-cemented horizon that has high bulk density (usually ≥1.5  Mg/m3) with high strength when dry. It has **all** of the following:

1. An air-dried clod must slake when fully immersed in water; **AND**
2. Brittle failure when moist (the horizon may contain coarse rock fragments but the fine-earth material must be sufficiently coherent to allow brittle failure); **AND**
3. It has at least slightly firm moist soil strength; **AND**
4. ***Either***
5. Extremely coarse or gross prismatic peds: the prisms have apedal-massive interiors, or break to secondary peds with horizontal dimensions of 100 mm or more, and the prism faces are defined by colours of chroma 3 or less, ***or***
6. The horizon is apedal-massive throughout, or has extremely coarse or gross prismatic peds, and the moist soil strength is very firm; **AND**
7. If roots are present, they are confined predominantly to planar voids between prisms or to worm burrows; **AND**
8. Moist penetration resistance is 3100 kPa or more; **AND**
9. It does not occur within an E horizon.

A fragipan is given the horizon notation suffix x, usually in combination with a B or BC horizon.

### Gley profile form

A gley profile form is defined by the presence of a reductimorphic horizon with an upper boundary within either 15 cm of the base of the A horizon or 30 cm of the mineral soil surface.

Soils with a gley profile form have usually been recognised as poorly or very poorly drained soils in the soil drainage classification of Milne (1995).

### Humus-pan

A humus-pan is a B horizon that is 10 mm or more thick and is normally given the horizon designation Bhm.

It has all of the following requirements:

1. It is apedal (massive); **AND**
2. It has either firm or stronger moist soil strength, brittle failure when moist, or moist penetration resistance of 3100 kPa or more;

**AND**

1. It has dominant moist colour value in the matrix of 3 or less, or moist colour value of 4 if the chroma is 2; **AND**
2. It contains more than 1.0% organic carbon.

### Ironstone-pan

An ironstone-pan is an indurated B horizon that is given the notation Bsm. It is dominantly composed of iron oxides with or without manganese oxides. It has **all** of the following characteristics:

1. The upper boundary is distinct, abrupt or sharp; **AND**
2. It is weakly or strongly indurated; **AND**
3. Fresh fracture surfaces are black and have a metallic lustre; **AND**
4. It forms a continuous horizon, or it is fractured into blocks of 100 mm (in horizontal dimension) or more; **AND**
5. It is 10 mm or more thick.

Ironstone-pans commonly occur at a textural discontinuity, in the fluctuating zone of a water-table. It is likely that the iron has been precipitated from iron-rich groundwater moving laterally. In Taranaki (Childs *et al.* 1990), the pans are porous and some appear to have formed as iron-oxide rhizomorphs, which have been progressively infilled and bound together by further precipitations of iron oxide. In these pans the mineralogy is dominated by varying proportions of goethite and ferrihydrite.

Ironstone-pans are not usually associated with eluvial horizons and do not occur in Podzols. They differ from ortstein-pans and placic horizons which are often associated with eluvial horizons in Podzols or Brown Soils, and which have high organic carbon levels. Ironstone pans meet the requirements of the material below a petroferric contact of Soil Taxonomy.

The pans are a barrier to plant roots. Heavy machinery is required to break them up for the installation of drains. The permeability of the pans is likely to be slow.

### Lithic contact

A lithic contact occurs at the contact of soil with underlying rock. The rock is hard or very hard and is impracticable to dig with a spade.

In situ rocks in New Zealand are commonly jointed at intervals of less than 100 mm, and consequently the lithic contact definition of Soil Taxonomy often fails to apply (Laffan 1979). The lithic contact is defined here as follows:

At a lithic contact, rock fragments accommodate one another with non-random orientation with respect to any geological structure that may be present, and cracks or joints are mostly less than 5 mm wide.

The lithic contact may be subdivided into coherent-lithic or shattered-lithic materials.

*Coherent-lithic materials* are equivalent to materials beneath the lithic contact of Soil Taxonomy. Cracks or joints occur at horizontal intervals of more than 100 mm. They often cause drainage impedance.

*Shattered-lithic materials* are similar except that joints or cracks may occur at intervals of less than 100 mm. Shattered-lithic materials differ from fragmental or skeletal materials in which there is no continuity of geological structure between adjacent rock fragments, and rock fragment faces do not accommodate one another. Shattered-lithic materials are more permeable than coherent-lithic materials, and offer a significant rooting volume.

### Mottled profile form

A mottled profile form is defined by **EITHER**

1. A redox-mottled horizon with an upper boundary within 15 cm of the base of the A horizon, or within 30 cm of the mineral soil surface; **OR**
2. A reductimorphic horizon with an upper boundary between 30 and 60 cm of the mineral soil surface.

Soils with a mottled profile form have usually been recognised as imperfectly drained soils in the soil drainage classification of Taylor and Pohlen (1962). Redox mottles are formed as a result of the reduction and solubilisation of iron and/or manganese, their translocation and concentration, and their oxidation and precipitation in the form of oxides. Mottles that have originated in some other way (e.g. rock colour patterns or skeletans) are excluded.

### Nodular horizon

A nodular horizon has more than 15% (by volume) nodules, as segregations of iron or aluminium oxyhydroxides, with some kaolinite, in a layer more than 10 cm thick. A nodular horizon is identified by the horizon notation suffix i.

The nodules are common features in Oxidic Soils and some Granular Soils (Wilson 1987). The frequency distribution of nodules is clustered in the <.2% range and the >.15% range. Few profiles are known to lie in between.

The nodular horizon limit is intended to exclude thin layers of rewashed nodules on colluvial footslopes, and also infrequent localised concentrations in soils with characteristically few nodules.

### Organic soil material

Organic soil material is soil material dominated by organic matter, excluding fresh litter (L horizons) and living plant material. Organic soil material usually has at least 18% organic carbon (approximately 30% organic matter) but it is defined here using morphology and simple analyses for easier recognition. Organic soil material has **EITHER**

1. ***All*** of the following:
   1. Colour value moist of 3 or less (after exposure to air) and colour value dry of 4 or less, ***and***
   2. Deformable failure, ***and***
   3. Weight loss of 65% or more by oven-drying a field-saturated sample;

**OR**

1. More than 20% (by volume) unrubbed fibre content;

**OR**

1. More than 35% (by weight) loss on ignition except in materials dominated by allophanic soil material or by limestone.

**OR**

1. 18% or more total carbon.

Unrubbed fibres are pieces of plant tissue large enough to be retained on a 100-mesh (0.15 mm) sieve, except for wood fragments that cannot be crushed or shredded in the hand and are larger than 2 cm in the smallest dimension. Rubbed fibre is the fibre that remains after rubbing a wet sample 10 times between the thumb and forefinger, or kneading a ball in the palm 10 times using firm pressure.

Organic soil materials that have been accumulated under wet conditions are subdivided into three classes, basedan on evidence of decomposition (Clayden and Hewitt 1989). These classes are used to distinguish soil groups of Organic Soils.

*Fibric soil material* (Of horizon) consists mainly of well-preserved plant remains that are readily identifiable in terms of botanical origin. The fibre content after rubbing is at least 75% by volume.

*Mesic soil material* (Om horizon) consists mainly of partially decomposed plant remains and does not meet the requirements of either fibric soil material or humified soil material. This material correlates with hemic soil material in other soil classification systems.

*Humified soil material* (Oh horizon) consists of strongly decomposed organic material with few or no identifiable plant remains other than resistant woody fragments >20 mm that cannot be reduced to fibres by crushing and shredding between the fingers. The fibre content is less than 15% after rubbing. This material correlates with sapric soil material in other soil classification systems.

### Ortstein-pan

1. An ortstein-pan is a B horizon that is normally given the horizon notation Bsm. It has **all** of the following requirements:Thickness of more than 10 mm; **AND**
2. The upper boundary is sharp or abrupt; **AND**
3. It is massive and has either firm or stronger moist soil strength, or has moist penetration resistance of 3100 kPa or more; **AND**
4. It does not meet the requirements of a humus-pan, and does not have the metallic lustre of fresh fracture surfaces of an ironstone-pan.

### Oxidic horizon

The oxidic horizon is a strongly weathered B horizon, consisting of mixed crystalline iron and aluminium oxides and kaolin group minerals, with low activity clay properties. It is given the horizon notation Bo. It has **ALL** the following requirements:

1. Weak or very weak primary ped strength and soil strength as determined by the unconfined resistance-to-crushing test at moist to dry soil water states; **AND**
2. Unconfined failure is friable or very friable over very moist to dry soil water states. Materials fail to predominantly 3 mm or smaller peds comprising silt- and sand-sized polyhedra and spheroids; **AND**
3. Primary peds slake rapidly in water to stable microaggregates which show no dispersion or slight dispersion after 100 inversions using the method of McQueen (1981); **AND**
4. Non-reactive or very weakly reactive to the reactive-aluminium test (Fieldes and Perrott 1966).

Oxidic horizons are clayey, with measured clay contents commonly exceeding 60%. The measured clay percentage is usually larger than in overlying A horizons, but clay increase is not a defining criterion because of the problem of quantifying clay contents in materials that are frequently difficult to disperse.

Materials are only slightly sticky and plastic in relation to clay content. Clay coatings are either visually absent or only present at frequencies of about 1%. The oxidic horizon has low activity clay accessory properties with ECEC and CEC less than 12 and 16 cmolc/kg clay respectively.

### Paralithic contact

A paralithic contact is the upper surface of rock or regolith material that has **ALL** of the following requirements:

1. It can be cut with difficulty with a spade; **AND**
2. Wet penetration resistance exceeds 2600 kPa; **AND**
3. Roots if present are few and confined to cracks; **AND**
4. If the overlying horizon is a reductimorphic or redox-mottled horizon, low chroma or high chroma mottles are less common below the contact.

The paralithic contact meets the definition of a paralithic contact of Soil Taxonomy, but without the restrictive requirement for spacing of cracks. The horizon beneath the contact is given the horizon designation CR. Paralithic contacts may occur either on weakly weathered or unweathered rocks which are not strongly lithified, or on saprolites which have become soft by strong weathering.

### Peaty topsoil

A peaty topsoil is 10 cm or more thick and is saturated for 30 or more consecutive days in most years (unless it is artificially drained), and has **EITHER**

1. Peat, sandy peat or loamy peat texture, **OR**
2. Slightly peaty texture (17–30% organic matter) if the clay content is less than 18%.

In some subgroups a peaty topsoil may be buried by a surface layer of new material of up to 60 cm in thickness.

### Perch-gley features

Perch-gley features are the morphologic indicators of saturation and reducing conditions caused by a water-table perched on a slowly permeable layer within the soil profile.

A horizon with perch-gley features **EITHER**

1. Has redox-segregations that occur mainly within peds, or in the case of an apedal soil, mainly within the soil matrix. Macro-void surfaces, either partings or pores, are dominated by greyish colours (moist chroma 2 or less, or moist chroma 3 and value 6 or more). Iron and manganese precipitates occur either adjacent to the greyish void surfaces as a selvedge or as discrete mottles within the soil mass; **OR**
2. Overlies a horizon that is both less gleyed (e.g. less redox-segregations) and has a matrix not dominated by greyish colours.

### Placic horizon

A placic horizon is a thin iron pan that is normally designated Bfm. It has **ALL** of the following:

1. It is 10 mm or less thick; **AND**
2. It is at least weakly indurated, and is black to reddish brown or dark red in colour. A black upper part can often be distinguished from a reddish brown lower part; **AND**
3. The upper and lower boundaries are sharp, and may be smooth, wavy or convolute in shape.

The placic horizon usually occurs as a single pan but in places can be bifurcated. It is equivalent to the placic horizon of Soil Taxonomy except that New Zealand iron pans are enriched in iron and organic matter without significant accumulations of manganese (Clayden *et al*. 1990).

### Podzolic-B horizon

A podzolic-B horizon is a B horizon that meets **one** of the following:

1. It meets the requirement of a Bh horizon (because it has colour value and chroma of 3 or less, or value 4 and chroma 2, dominant in the matrix, and contains more than 1% organic carbon). The fabric has sand- or silt-size pellet-like aggregates, coats on mineral grains, or both.

**OR**

1. (a) It is associated with an overlying (but not necessarily immediately overlying) E horizon (i.e. Ea horizon) in which weathered films on sand and silt particles are either absent, very thin or discontinuous, so that the colour of the horizon is mainly determined by the colours of the uncoated grains. The moist colour value of the E horizon is 4 or more (or a dry colour value is 5 or more). It has higher colour value or lower chroma and less well developed pedality than an underlying B horizon;

***and***

(b) The B horizon (or some part of it) is 5 cm or more thick and meets the requirements of a Bs (or Bs(g) or Bs(f)) horizon because it has a strong or very strong reactive-aluminium test, and at least *one* of the following:

* 1. Reddish hue and highest chroma at the top of the horizon, *or*
  2. Earthy apedal with fine spheroids, or weakly developed blocks or polyhedra, *or*
  3. Very weak or weak soil strength when moist or dry, *or*
  4. Sand- or silt-sized pellet-like aggregates;

**OR**

1. It meets the definition of a Bs horizon (part 2(b) above) and has in addition, coatings of value 4 or less ***either***
   1. On 50% or more ped faces, ***or***
   2. As patches covering 20% or more of cut faces.

### Reactive-aluminium test

This test indicates the presence of reactive hydroxy-aluminium groups, as occur for example in allophane and aluminium-humus complexes (Milne *et al*. 1991).

Using the procedure of Fieldes and Perrott (1966), 1 drop of saturated sodium fluoride solution is placed on a small test sample of soil, which has been smeared on to a filter paper treated with phenolphthalein indicator. The soil sample must be field moist. For classification, the reactivity of the soil sample is placed into one of the following classes.

|  |  |  |
| --- | --- | --- |
| ***Reactivity Class*** | | ***Class Definition*** |
| 0 | non-reactive | No colour within 2 minutes. |
| 1 | very weak | Pale red or light red (5R 6/1) |
|  |  | just discernible within 2 minutes. |
| 2 | weak | Pale red or light red (5R 6/1) within 1 minute. |
| 3 | moderate | Red or weak red (5R 4 or 5/-) |
|  |  | within 1 minute. |
| 4 | strong | Dusky red or dark red (5R 3/-) |
|  |  | after 10 seconds. |
| 5 | very strong | Dusky red or dark red (5R 3/-) within 10 seconds. |

### Redox-mottled horizon

A redox-mottled horizon is a horizon affected in parts by reducing conditions as indicated by the presence of redox-segregations. These usually indicate intermittent saturation of the soil by water. A redox-mottled horizon is identified by the horizon notation suffix (f) or (g).

A redox-mottled horizon has 2% or more redox segregations. If low chroma colours (moist chroma 2 or less, or moist chroma 3 with value 6 or more) occur, they must occupy less than 50% of the matrix exposed in a cut face of the horizon and are not dominant on ped faces.

The intermittent wetness may be caused by intermittent perched water, or by the fluctuating upper limits of deeper more prolonged groundwater. A redox-mottled horizon may represent more prolonged saturation and reduction in parent materials that are predominantly andesitic or basaltic compared with other parent materials.

### Redox segregations

Redox segregations are mottles or concretions formed as a result of the reduction and solubilisation of iron and/or manganese, their translocation, concentration, and their oxidation and precipitation in the form of oxides (Clayden and Hewitt 1989). They may occur as low or high chroma colours, or both.

The nature of the water table is indicated by the association of low and high chroma colours. If subject to reduction by perched water, the low chroma colours are likely to be at ped or pore surfaces and the high chroma colours are likely to be within the soil matrix. If the soil is subject to reduction by groundwater, the low chroma colours are likely to be within the soil matrix and the high chroma colours are likely to be at ped or pore surfaces. Reducing conditions may also be indicated by the presence of sufficient ferrous iron to give a positive reaction to a,a'-dipyridyl (Childs 1981).

### Reductimorphic horizon

A reductimorphic horizon has a slightly peaty texture class, or low chroma colours (moist chroma 2 or less, or moist chroma 3 with value 6 or more) that occupy 50% or more of the matrix exposed in a cut face of the horizon or are dominant on ped faces. A reductimorphic horizon includes any subjacent layers or interlayers of peaty soil material.

A reductimorphic horizon is a horizon strongly affected by reducing conditions as indicated by greyish colours consistent with long saturation by water. The prolonged wetness may be caused by a water-table perched on a slowly permeable layer within the soil profile or by a groundwater-table. A reductimorphic horizon is identified by the horizon notation suffix g or r.

### Slowly permeable layer

A slowly permeable layer is one in which the vertical saturated hydraulic conductivity is less than 4 mm/h (1.0 × 10–6 m/s) as measured by a standard method. If no measurement is available, then the horizon can be identified by the following morphological characteristics (Griffiths 1991):

A slowly permeable layer meets **EITHER**

1. (a) The soil material is pedal; ***and***

(b) More than half of the peds are coarser than 10 mm (mean of the x and y axes in a horizontal plane) and meet *one* of the following:

1. Peds 20 to 50 mm, with degree of packing at least extremely high; *or*
2. Peds 50 to 100 mm with degree of packing at least very high; *or*
3. Peds 100+ mm with degree of packing at least high;

**OR**

2. ***Either***

1. The soil material is sand or loamy sand and has an extremely high degree of packing; ***or***
2. The soil material has a particle-size group other than sandy and has at least a high degree of packing.

A slowly permeable layer is significant for the land use, genetic and hydrological understanding of soils. Other diagnostic horizons that frequently also function as a slowly permeable horizon are fragipans, argillic horizons, densipans, humus-pans or ortstein-pans and lithic or paralithic contacts.

### Saline soil material

Soil salinity refers to the accumulation of water-soluble salts, mainly of sodium, calcium and magnesium. These can severely affect plant growth and land use, and increase soil erosion (Hazelton and Murphy 2017, p. 95).  
  
Most soils generate some salt as a product of chemical weathering, with composition and concentration determined by the parent material lithology. Soils may also receive additional salt at their surface, transported by wind and/or rain. Some soils are affected by saline groundwater from marine or hydrothermal sources.  
  
Under higher rainfall regimes and under good drainage conditions, these salts are leached from the soil (Hewitt et al, 2021). Where rainfall is too low to remove salt (or a profile is in a low-lying, water-receiving location), salts can accumulate and may ultimately precipitate as crystals in the profile and/or on the soil surface.  
  
Soil salinity is somewhat difficult to measure in the field in ways that can be strongly related to plant growth (DERM, 2011). As a compromise, the electrical conductivity (EC) of a 1:5 solution of soil to deionised water is measured. Results exceeding 0.8 mS/cm within in the top 60 cm of the soil profile are considered significant enough in the classification of Gley, Recent, Raw, and Semi-arid soil orders.   
  
Note that salinity at any given location (including within the profile) is expected to be highly variable across seasons, and will generally be at its maximum towards the end of a dry summer.

### Sodic features

A horizon with sodic features, denoted by the horizon notation suffix n, has significant exchangeable sodium and is not necessarily characterised by a high soluble salt content. It has **BOTH**

1. ***Either***

1. Exchangeable sodium percentage of 6% or more (or exchangeable sodium is 0.7 cmolc/kg or more); ***or***
2. When a 10 mm diameter sample which has been air-dried is placed in distilled water or salt free water a cloud of dispersed clay will form within 10 minutes around the sample. This test will not apply if the soil is in any degree cemented; **AND**

2. ***Either***

1. Clay or clay/organic coatings have colour value 4 or less;
2. Prismatic or blocky peds; ***or***
3. It may be overlain by an Ew, Ew(g) or Ew(f) horizon, or have skeletans (visible on dry ped faces) near the top of the horizon.

### Tephric soil material

Tephric soil material occurs in or below the soil solum. It includes:

1. Tephra — unconsolidated, primary pyroclastic products of volcanic eruptions (Froggatt and Lowe 1990),such as ash, cinders, lapilli, pumice, scoria, blocks, or volcanic bombs, **AND**
2. Tephra deposits — material derived at least partly from tephra that has been reworked and mixed with material from other sources. They include tephric loess, tephric blown sand and volcanogenic alluvium. As a general guide, tephric deposits from andesitic sources have more than 10% volcanic glass in the sand fraction and those from rhyolitic sources have more than 40% volcanic glass in the sand fraction.

Tephric soil material may include soil materials that meet the requirements of allophanic soil material or vitric soil material. It is used to distinguish soil groups of the Raw Soils and Recent Soils, and parent material classes at soil series level.

### Vitric soil material

Vitric soil material (Parfitt 1985) has more than 35% coarse-fraction (2 mm or greater, by volume) of which 60% is pumice or cinders, or there is more than 40% sand of which more than 30% is volcanic glass (or crystals coated with glass) (Eden 1990).

### Weathered-B horizon

A weathered-B horizon shows evidence of chemical alteration of the original parent material it is derived from and is designated Bw, Bw(g), Bw(f), etc. It has at least **ONE** of the following:

1. Redder hue or higher chroma than an underlying horizon in similar materials; **OR**
2. Have spheroidal, blocky, polyhedral, tabular, prismatic, columnar or platy pedality which distinguish the horizon from a BC or C horizon below; **OR**
3. Evidence of either partial or complete decalcification, i.e. less CaCO3 than the underlying horizon which may contain redeposited carbonates.

A weathered-B horizon may also meet the requirements of a redox-mottled horizon, argillic horizon, cutanic horizon, or brittle-B horizon.

# Key to soil orders

NOTE: Anthropic soils should be shifted to the front of the key.

In the keys to orders, groups or subgroups, any surface layer of new material, e.g. fresh alluvium, that is less than 30 cm thick, is not considered as part of the soil for assignment to orders, groups or subgroups, except in the Recent Soils or Raw Soils, or Sulphuric Gley or Recent Gley groups of the Gley Soils. A surface layer of new material can be recognised because it will not meet the requirements of the key for any order or group except those specified above. Transitional horizons (e.g. AB or A/B horizons) are not included when considering horizon notations in the key unless explicitly stated.

**If any soil has an overthickened A horizon with its base at 45 cm or more from the mineral soil surface and is not mottled within 30 cm of the mineral surface, the key should be entered directly at Recent Soils.**

**O**. Soils that have horizons that consist of organic soil material (including soils that have skeletal layers in which the matrix of the coarse rock fragments consists of organic soil material) that within 60 cm of the soil surface are **EITHER**

1. 30 cm or more thick (cumulative) and are entirely formed from soil materials that have accumulated under wet conditions (they are saturated with water for at least 30 consecutive days in most years, or have been artificially drained) (O horizons), **OR**
2. 40 cm or more thick and are formed from partly decomposed or well decomposed litter (F and H horizons).

**Organic Soils** (p.82)

**G**. Other soils that have **EITHER**

1. a gley profile form in which the reductimorphic horizon (but not including soils with pedal horizons in which the defined greyish colours occur on ped faces but not in 50% or more of the matrix) meets ***all*** of the following:
   1. the reductimorphic horizon has a lower boundary of at least 90 cm from the mineral soil surface. If shallower, the reductimorphic horizonmust have a lithic or paralithic contact, or rest upon a permeable sandy-skeletal layer with a base that extends to 90 cm or more from the mineral soil surface, or to the base of the B horizon, ***and***
   2. there is no underlying fragipan with matrix of chroma 3 or more dominant, duripan or underlying podzolic-B horizon, ***and***
   3. a distinct topsoil occurs at the surface or is buried with its upper surface within 60 cm of the mineral soil surface, ***and***
   4. there is no horizon with a moderately fluid or very fluid fluidity class within 30 cm of the mineral soil surface,

***and***

* 1. there is no allophanic soil material with a total of 35 cm thickness or more occurring within 60 cm of the mineral soil surface

**OR**

1. an ironstone pan with an upper surface 30 cm or less from the mineral soil surface, and has sufficient ferrous iron to give a positive reaction to a,a'-dipyridyl at some time of the year.

**Gley Soils** (p.63)

**U**. Other soils that meet **ALL** of the following

* 1. pH of less than 5.5 in the major part from the base of the A horizon to 60 cm from the mineral soil surface, **AND**
  2. a B horizon which in the major part:
  3. is pedal with clay or humus coatings present on 10% or more ped faces, ***and***
  4. has slightly firm or stronger soil strength when moist unless the texture is sandy loam or sandy clay loam, ***and***
  5. has less silt than clay, unless there are weathered coarse rock fragments, ***and***
  6. has sandy loam or finer texture, ***and***
  7. has base deeper than 100 cm, **AND**

1. do not have
   1. an oxidic or cutanoxidic horizon, ***nor***
   2. a layer or layers of allophanic soil material that totals 35 cm or more thick within 60 cm of the mineral soil surface, ***nor***
   3. coarse rock fragments, other than quartz, that are strongly or very strongly indurated, **AND**
2. have either an E horizon, or the uppermost subhorizon of the B has colour value of 5 or more.

**Ultic Soils** (p.126)

**Z**. Other soils that have either a podzolic-B horizon, or an ortstein-pan, that has pH less than 5.5 in some part or a humus-pan.

**Podzols** (p.99)

1. Other soils that have a layer or layers of allophanic soil material that total 35 cm or more thick, and occur within 60 cm of the mineral soil surface. If a lithic or paralithic contact is reached at a depth of less than 35 cm from the mineral soil surface, the thickness requirements do not apply, but instead, all mineral horizons above the lithic or paralithic contact must meet the criteria for allophanic soil material.

**Allophanic Soils** (p.41)

1. Other soils that have **BOTH**
2. a layer of vitric soil material extending from the mineral soil surface to 25 cm or more, or 35 cm or more thick occurring within 60 cm of the mineral soil surface, **AND**
3. a weathered-B horizon 5 cm or more thick.

**Pumice Soils** (p.105)

**E**. Other soils that have **ALL** the following

1. Dominantly derived from calcareous, mafic or ultramafic rock classes; AND
2. an A horizon that in the major part has both
3. moist colour value of 3 or less, ***and***
4. *either* moderate or strong pedality (with peds that are less than 60 mm in size), is earthy apedal, or has cracks 4 mm or more wide that extend to a depth of 30 cm or more at some time of the year, *or* is peaty, **AND**
5. has either
6. a visible reaction to 10% HCl in the soil matrix at 60 cm or less from the mineral soil surface, ***or***
7. has a weathered-B, argillic or cutanic horizon (more than 10 cm thick) in which the major part (to 60 cm from the mineral soil surface or to its base, whichever is less) has pH of 5.9 or more, moderate or strong pedality, and is sticky or very sticky, or, if pH is below 5.9, has a matrix colour value of 4 or less, a moderate to strong polyhedral pedality, and is moderately or very sticky, **AND**
8. has in some part of the B horizon to its base, or to 90 cm from the mineral soil surface, whichever is less, either
9. coarse rock fragments that are not very highly weathered or completely weathered, ***or***
10. a subhorizon that is not clayey, ***or***
11. the uppermost subhorizon of the B has colour value of 5 or more.

**Melanic Soils** (p.76)

**S**. Other soils that have **ALL** of the following

1. no fragipan, **AND**
2. a weathered-B horizon 10 cm or more thick, or a calcareous horizon (with evidence of pedogenic carbonate), **AND**
3. no primary calcium carbonate minerals in the sand fraction of the B horizon, **AND**
4. ***either***
5. a calcareous horizon, or a horizon with pH of 7.5 or more, within 90 cm of the soil surface (or within 150 cm if the particle-size class is dominantly sandy or sandy-skeletal), ***or***
6. P retention of 15% or less in the major part of the B horizon to 60 cm depth, and any worm mixed horizon at the base of the A horizon is less than 5 cm thick.

**Semiarid Soils** (p.121)

**X**. Other soils that have an oxidic horizon more than 30 cm thick with an upper boundary between 20 and 60 cm from the mineral soil surface.

**Oxidic Soils** (p.87)

**N**. Other soils that have **BOTH**

1. a B horizon which to its base, or to 90 cm from the mineral soil surface, whichever is less, is ***both***
   1. clayey throughout; ***and***
   2. if any coarse-fragments of rock material occur they are either very highly weathered or completely altered, **AND**
2. a cutanoxidic horizon, or a moderately or strongly pedal cutanic or argillic horizon occurs that has ***either***
   1. an overlying or overlapping reductimorphic horizon within 15 cm of the base of the A horizon, or 30 cm of the mineral soil surface; ***or***
   2. polyhedral peds 20 mm or less in size in most of the B horizon within 60 cm of the mineral soil surface.

**Granular Soils** (p.71)

**P**. Other soils that have textures of loamy fine sand or finer in some part from the base of the A horizon to 60 cm from the mineral soil surface, and have **EITHER**

1. a reductimorphic horizon or E horizon, that overlies a fragipan, duripan or argillic horizon; **OR**

2. ***both***

(a) between the base of the A horizon to 60 cm from the mineral soil surface the matrix throughout is *either*

1. hue 10YR or yellower with chroma 3 or less and value 4 or more (all colours moist), *or*
2. hue 10YR or yellower with chroma 4 or 5 or chroma 3 with value 3, or hue 2.5Y or yellower with chroma 6 or more (all colours moist, see Figure 2);andP retention is less than 30% in the uppermost subhorizon (10 cm or more thick) of the B or BC horizon.

***and***

(b) a B or BC horizon that is 10 cm or more thick, and has *either*

1. a fragipan, duripan or brittle-B horizon, *or*
2. a weathered-B horizon that has in part a moderately or strongly pedal subhorizon with blocky, polyhedral or prismatic peds and slightly firm or greater soil or ped strength, *or*
3. argillic horizon, calcareous horizon, or a cutanic horizon that has sodic features either within or immediately beneath it, *or*
4. an eluvial horizon , skeletans on B horizon peds, or skeletans as apparent segregations of relatively higher colour value in B or BC horizons (“two-tone”).

**Pallic Soils** (p.91)

**B**. Other soils that have **BOTH**

1. a weathered-B, argillic or cutanic horizon 10 cm or more thick with a lower boundary at 30 cm or more from the mineral soil surface, **AND**
2. in the B horizon, a subhorizon that has in the matrix ***either***
   1. hue 7.5YR or redder, or hue 10YR and chroma 6 or more; ***or***
   2. hue 10YR or yellower with chroma 4 or 5 or chroma 3 with value 3, or hue 2.5Y or yellower with chroma 6 or more (all colours moist, see Figure 2); and P retention is 30% or more, or the reactive-aluminium test is at least moderate, in the uppermost subhorizon (10 cm or more thick) of the B horizon, ***or***
   3. the texture is sand or loamy sand in the B horizon to its base, or to 60 cm from the mineral soil surface, which ever is less.

**Brown Soils** (p.51)

**A**. Other soils that either

1. consist of Anthropic material with combined thickness of >30 cm within 90 cm of the soil surface, or constituting the entire soil thickness above a lithic or paralithic contact; OR
2. are interpreted to have been affected by truncation (i.e., excavation of solum material) by the action of people. This truncation reached at least as deep as the natural in-situ A or AB horizon (i.e., to the upper boundary of the B horizon or deeper).

**Anthropic Soils** (p.47)

**R**. Other soils that **BOTH**

* 1. have a distinct topsoil at the surface or buried with its upper surface within 60 cm of the mineral soil surface, or at least moderate structural development within 15 cm of the mineral surface, or a weathered-B horizon; **AND**
  2. do not have any horizon with a moderately fluid or very fluid fluidity class within 30 cm of the mineral soil surface.

**Recent Soils** (p.114)

**W**. Other soils.

**Raw Soils** (p.109)

VALUE

3

3

3

3

4

4

4

4

5

5

5

5

6

+

6

+

6

+

6

+

8

7

6

5

4

3

CHROMA

7.5

YR

10

YR

Y

2.5

5

Y

**BROWN**

**BROWN**

**PALLIC**

**PALLIC**

**PALLIC**

PALLIC or BROWN

PALLIC or BROWN

PALLIC or BROWN

Providing other requirements are met:

|  |  |  |
| --- | --- | --- |
|  | = | assignment directly to brown soils |

= assignment directly to Brown Soils.

|  |  |  |
| --- | --- | --- |
|  | = | assignment directly to Pallic Soils |

= assignment directly to Pallic Soils.

|  |  |  |
| --- | --- | --- |
|  | = | For the uppermost subhorizon (10 cm or more thick) of the B horizon: |

= For the uppermost subhorizon (10 cm or more thick) of the B horizon:

if P retention is 30% or more, or the reactive-aluminium test is at least

moderate, then assignment is to Brown Soils,

if P retention is less than 30% then assignment is to Pallic Soils.

***Figure 2.*** *Colour criteria, and colours where P retention and the reactive- aluminium test is used to differentiate Brown Soils from Pallic Soils and Recent Soils. See part 2(a) of the Pallic Soils, and part 2(a) and 2(b) of the Brown Soils in the key to orders.*

# Allophanic Soils

### CONCEPT OF THE ORDER

Allophanic Soils have properties that are strongly influenced by minerals with short-range order, especially allophane, imogolite and ferrihydrite. They are characteristically weak in strength and sensitive, with very low bulk density. They occur mostly in volcanic parent materials, especially ash and basaltic scoria, but occur also in quartzo-feldspathic and tuffaceous (greywacke) sandstone.

### CORRELATION

The order comprises mainly yellow-brown loams but also includes weakly weathered red loams and brown loams and some upland and high country yellow-brown earths of the NZ Genetic Soil Classification. The soils correlate predominantly with the Andisols of Soil Taxonomy.

### OCCURRENCE

Allophanic 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.

### ACCESSORY PROPERTIES OF THE ORDER

1. Short-range-order minerals. The soil matrix as well as pore surfaces are dominated by the clay minerals allophane, imogolite and ferrihydrite, and/or aluminium-humus complexes. The soil materials have very high specific surface area. Measured clay contents generally range from 10 to 25% though particle-size measurement is difficult because of aggregation and the “true” or primary clay contents may often be considerably higher. P retention is high or very high.
2. Low bases. Sum of bases are low to very low and range from less than 1 to 10 cmolc/kg, in subsoils and unfertilised topsoils.
3. Volcanic or greywacke parent materials. Predominantly in andesitic, rhyolitic or mixed tephra, they also occur in soil materials from sandstone (greywacke) of humid uplands and high country and basalt scoria or pumice.
4. Rapid mineral weathering. Volcanic glass and feldspar dominate the sand fractions of soils in igneous parent materials, and are the primary source of the short-range-order minerals. Feldspars are most likely the primary source in non-igneous parent materials. Typically they have an Amorphic mineralogy class.
5. Rapid permeability and high water retention. The macroporosity is very high and rapid drainage occurs at low soil moisture tensions. Water contents at 1500 kPa soil moisture tension are very high.
6. Well drained. Although poorly, imperfectly and moderately well drained soils occur, well drained soils are predominant
7. Good rooting medium. Bulk density is very low and there is little resistance to root extension. In many soils the potential root depth is very deep.
8. Active soil fauna. Microbial biomass is generally high.
9. Stable topsoils. Soils resist pugging under the impact of machinery or grazing animals in wet weather. The water content at field capacity is less than the plastic limit. Topsoil and subsoil horizons are friable, and organic/mineral complexes are stable. Carbon contents are medium to high. Exposed topsoil may be subject to wind erosion.
10. High shrinkage potential. Soil materials have high potential to shrink on drying. Rewetting may not achieve the original volume.
11. Slight to insignificant erosion under pasture. Generally, the erosion potential is low, except on steep slopes or exposed sites and under cultivation on rolling slopes.
12. Sensitive. A pronounced loss of strength occurs on disturbance.
13. Limited fertility. There are usually requirements for phosphorus, potassium and magnesium on dairy farms. There are no significant trace element deficiencies although cobalt is marginal in more strongly leached Allophanic Soils. Pasture may respond to lime where pH is less than 5.3. Sulphate reserves are held in B horizons. P retention and phosphate fixation are high in topsoils.
14. Moist climate. Precipitation exceeds 1000 mm and soil moisture deficits are either absent or occur for only short periods.

### SUMMARY OF ALLOPHANIC SOILS HIERARCHY

|  |  |  |  |
| --- | --- | --- | --- |
| Group | | Subgroup | Example of series |
| **LP** | Perch-gley | Ironstone | - |
|  |  | Typic | Awatuna |
| **LG** | Gley | Peaty | Rahotu var. |
|  |  | Typic | Glenn |
| **LI** | Impeded | Mottled-ironstone | pt. Okato var. |
|  |  | Mottled | Tipoka |
|  |  | Typic | Bruntwood |
| **LO** | Orthic | Mottled | Oeo |
|  |  | Vitric-acidic | Rowan |
|  |  | Vitric | Lepperton |
|  |  | Acidic | Patua |
| Typic Tirau | | | |

### KEY TO GROUPS OF ALLOPHANIC SOILS

**LP** Allophanic Soils that have *both*

1. Perch-gley features, *and*
2. Either a peaty topsoil, or within 15 cm of the base of the A horizon or 30 cm of the mineral soil surface, have
   1. a reductimorphic horizon, or
   2. a redox-mottled horizon if the parent material is predominantly andesitic or basaltic.

**PERCH-GLEY ALLOPHANIC SOILS**

**LG** Other Allophanic Soils that have a peaty topsoil, or within 15 cm of the base of the A horizon or 30 cm of the mineral soil surface, have *either*

1. a reductimorphic horizon, *or*
2. a redox mottled horizon if the parent material is predominantly andesitic or basaltic.

**GLEY ALLOPHANIC SOILS**

**LI**  Other Allophanic Soils that have a slowly permeable layer, or horizon that is at least weakly indurated, within 90 cm of the mineral soil surface.

**IMPEDED ALLOPHANIC SOILS**

**LO** Other Allophanic Soils.

**ORTHIC ALLOPHANIC SOILS**

### KEY TO SUBGROUPS OF ALLOPHANIC SOILS

**LP** PERCH-GLEY ALLOPHANIC SOILS

Perch-gley Allophanic Soils occur in sites that are periodically saturated (unless artificially drained). Wetness and associated reducing conditions are indicated by brownish or reddish mottles. The wetness is caused by the perching of water on a slowly permeable subsurface layer, although a groundwater-table may also be present.

**LPI** Perch-gley Allophanic Soils that have an ironstone-pan within 90 cm of the mineral soil surface.

**Ironstone Perch-gley Allophanic Soils**

**LPT** Other soils.

**Typic Perch-gley Allophanic Soils**

**LG** GLEY ALLOPHANIC SOILS

Gley Allophanic Soils occur in sites that are periodically saturated (unless artificially drained). Wetness and associated reducing conditions are indicated by brownish or reddish mottles. The wetness is caused by a groundwater-table.

**LGO** Gley Allophanic Soils that have a peaty topsoil.

**Peaty Gley Allophanic Soils**

**LGT** Other soils.

**Typic Gley Allophanic Soils**

**LI** IMPEDED ALLOPHANIC SOILS

Impeded Allophanic Soils have a subsurface horizon that acts as a barrier to the movement of water or penetration of roots.

**LIMI** Impeded Allophanic Soils that have an ironstone-pan within 90 cm of the mineral soil surface and that have a mottled profile form.

**Mottled-ironstone Impeded Allophanic Soils**

**LIM** Other soils that have a mottled profile form.

**Mottled Impeded Allophanic Soils**

**LIT** Other soils.

**Typic Impeded Allophanic Soils**

**LO** ORTHIC ALLOPHANIC SOILS

Orthic Allophanic Soils are permeable soils without barriers to deep penetration of roots. They are well, moderately well, or imperfectly drained.

**LOM** Orthic Allophanic Soils that have a mottled profile form.

**Mottled Orthic Allophanic Soils**

**LOVA** Other soils that have both

1. either
   1. coatings on pores (excluding root linings), or gel-like masses bridging sand grains or coating coarse-fragments, that have hue 7.5YR or redder, value 5 or less and chroma 3 or more, or
   2. pH less than 5.5 in some part of the B or BC horizon to 60 cm from the mineral soil surface, and
2. allophanic soil material that is formed predominantly from tephric soil material and has 50% or more sand (by weighted average).

**Vitric-acidic Orthic Allophanic Soils**

**LOV** Other soils in which allophanic soil material layers are formed predominantly from tephric soil material and have 50% or more sand (by weighted average).

**Vitric Orthic Allophanic Soils**

**LOA**  Other soils that have, in some part of the B or BC horizon to 60 cm from the mineral soil surface, either

1. coatings on pores (excluding root linings), or gel-like masses bridging sand grains or coating coarse-fragments, that have hue 7.5YR or redder, value 5 or less and chroma 3 or more, or
2. pH less than 5.5.

**Acidic Orthic Allophanic Soils**

|  |  |
| --- | --- |
| **LOT** | Other soils. |

**Typic Orthic Allophanic Soils**

# Anthropic Soils

### CONCEPT OF THE ORDER

Anthropic Soils are soils that have been created or significantly altered by human activity. This includes the truncation (i.e., excavation) of natural soils by earth-moving equipment, the relocation of soils from their original sites, or the mixing of natural soils in a way that significantly alters their original character. Additionally, Anthropic Soils may be formed through the through deposition of thick layers of organic or inorganic material that may also contain artefacts. Their classification reflects the way in which they were created or altered, and the kinds of materials used.

Note that soils that have been drastically disturbed but have been restored to the extent that they will meet the requirements of orders other than Recent Soils or Raw Soils, will not be assigned to Anthropic Soils. For this reason Anthropic soils are placed late in the Key to Orders but before Recent Soils and Raw Soils.

### CORRELATION

Anthropic Soils were not formally part of the NZ Genetic Soil Classification although Anthropic Soils were described in some soil survey reports. In Soil Taxonomy, the soils either correlate with soils containing an Anthropic or Plaggen Epipedon, Entisols or are unclassified.

### OCCURRENCE

Anthropic Soils are most extensive in urban and peri-urban areas and areas that have been mined. While not necessarily covering extensive areas, soils sufficiently altered by Māori are of particular cultural interest as the oldest examples of anthropogenic alteration of soils in NZ.

### ACCESSORY PROPERTIES OF THE ORDER

1. Soil characteristics and the relationships between soils and landforms do not have the orderliness of natural soils.
2. Drainage has often been changed significantly from the original state.
3. Soil properties depend upon both the nature of the manufactured or natural materials and the nature of the soil manipulation.
4. Land surfaces are artificial.

### SUMMARY OF ANTHROPIC SOILS HIERARCHY

|  |  |  |
| --- | --- | --- |
| Group | | Subgroup |
| **AT** | Truncated | Rocky Typic |
| **AR** | Refuse | Buried Typic |
| **AO** | Māori | Artefact Organic Fill |
| **AM** | Mixed | - |
| **AF** | Fill | Compacted  Wet  Stony-tailings  Artifact  Earthy |

### KEY TO GROUPS OF ANTHROPIC SOILS

**AT** Anthropic Soils that have been affected by truncation of the solum by the action of people. This truncation reached at least as deep as the natural *in-situ* A or AB horizon (i.e., to the upper boundary of the B horizon or deeper). The natural *in-situ* materials occur at or within 30 cm of the soil surface.

**TRUNCATED ANTHROPIC SOILS**

#### AO

Other Anthropic Soils that have been modified or altered through Māori cultural practice, often forming a distinct ‘cultural layer’ with artefacts (e.g. midden sites). These soils meet the following criteria

* + - 1. Contain additions to horizon(s) in the form of manufactured or natural mineral (e.g., coarse rock fragments, sand), organic or biogenic material (e.g., seaweed, charcoal, ash, shells) through Māori cultural practice; and
      2. The modified horizon(s) have a combined thickness of at least 30 cm, with an upper boundary either at the land surface or within 90 cm if buried.

**MĀORI ANTHROPIC SOILS**

**AR** Other Anthropic Soils that have *either*

1. a layer comprising natural organic waste, or manufactured organic material, including plastics, that is at least 30 cm thick and has an upper boundary at the land surface, or is buried within 90 cm of the land surface, or
2. has a methane content sufficient to be detected by odour.

**REFUSE ANTHROPIC SOILS**

**AM** Other Anthropic Soils in which the original soil horizonation has been destroyed by deep ripping, deep subsoil lifting, or similar practices.

**MIXED ANTHROPIC SOILS**

**AF** Other Anthropic Soils.

**FILL ANTHROPIC SOILS**

### KEY TO SUBGROUPS OF ANTHROPIC SOILS

**AT** TRUNCATED ANTHROPIC SOILS

Truncated Anthropic Soils result from cutting away any existing soil, by mechanical equipment, leaving material that would be recognised as a B, BC, C, CR or R horizon. The scalped surface may be overlain by up to 29 cm of soil, deposited for landscaping purposes.

**ATX** Soils with a lithic contact within 60 cm of the soil surface.

**Rocky Truncated Anthropic Soils**

**ATT** Other soils.

**Typic Truncated Anthropic Soils**

**AO – MĀORI ANTHROPIC SOILS**

These soils are attributed to Māori cultural activity, such as Māori-initiated construction or burial, gardening and horticultural practice, or signs of customary resource activity. Māori Anthropic Soils occur throughout NZ, at sites where Māori cultural activity has significantly altered the soil profile, through alteration, excavation and/or redistribution of soil from original sites. Examples include pā sites, trenches, cultural fortifications, villages (papa kāinga), burial sites (ūrupa). For gardening, horticulture, and cropping soil management practices result in the addition of local mineral material (e.g., coarse rock fragments, and sand) or the addition of organic or biogenic material (e.g., seaweed, charcoal, ash, shells), to ameliorate and enhance the physical, chemical, and biological properties of a soil (e.g., soil fertility, drainage, aeration, temperature). Customary resource activity often results in waste material altering soils and landforms (e.g., middens).

**AOA**

Soils with a horizon containing Māori artefacts or other manufactured material (e.g., some middens), or a horizon resulting from excavation and redistribution of soil material for construction purposes (e.g., Pā sites, fortifications, burial sites), greater than a combined thickness of 30 cm within 90 cm of the mineral soil surface.

**Artefact Māori Anthropic Soils**

**AOO**

Soils with a horizon containing organic material (plant- or animal-derived) added by Māori primarily to enhance soil conditions with a thickness greater than 30 cm within 90 cm of the mineral soil surface.

**Organic Māori Anthropic Soils**

**AOF**

Other soils with a horizon of additions by Māori greater than a combined thickness of 30 cm within 90 cm of the mineral soil surface.

**Fill Māori Anthropic Soils**

**AR** REFUSE ANTHROPIC SOILS

Refuse Anthropic Soils occur in sites where household, land management, urban or industrial waste has been dumped and which have significant organic matter, comprising vegetation, animal or manufactured material such as plastics, paper or timber.

**ARW** Refuse anthropic soils that are saturated within 60 cm of the mineral soil surface at some time of the year.

**Wet Refuse Anthropic Soils**

**ARB** Soils in which refuse is buried beneath an overburden of soil or rock material greater than 30 cm thick.

**Buried Refuse Anthropic Soils**

**ART**  Other Soils.

**Typic Refuse Anthropic Soils**

**AM**  MIXED ANTHROPIC SOILS

Mixed Anthropic Soils occur where the original soil has been disturbed by mechanical procedures such as deep ripping, lifting, flipping or recontouring (e.g., hump-and-hollowing) to improve soil characteristics such as increasing fertility or breaking up drainage-impeding horizons (e.g., placic horizons, ortstein or ironstone pans). The original soil, if known, may be appended to the name in parentheses, for example, Typic Mixed Anthropic Soil (Perch-Gley Pallic Soil).

**AMI**

Soils comprising a modified tephra stratigraphy by mechanical flipping to a depth greater than 30 cm from the mineral soil surface.

**Inverted-tephric Mixed Anthropic Soils**

**AMZ**

Soils comprising a soil horizon stratigraphy that is modified by mechanical flipping, lifting, or mixing to a depth greater than 30 cm from the mineral soil surface in order to improve drainage by breaking up drainage-impeding soil horizons, often combined with recontouring of the soil surface (e.g., hump-and-hollowing).

**Inverted-impeded Mixed Anthropic Soils**

**AMT**

Other soils mechanically mixed to a depth greater than 30 cm from the mineral soil surface.

**Typic Mixed Anthropic Soils**

**AF** FILL ANTHROPIC SOILS

Fill Anthropic Soils result from the deposition of dominantly inorganic material including soil material from elsewhere, rock debris, dredged sediments or manufactured material such as bricks, concrete, or metals.

**AFC** Soils that have been compacted and have a bulk density of 1.5 Mg/m3 or more.

**Compacted Fill Anthropic Soils**

**AFW** Other soils that are wet within 60 cm of the mineral soil surface at some time of the year.

**Wet Fill Anthropic Soils**

**AFS** Other soils that have a coarse layer (added rock fragments, concrete, bricks) of more than 30 cm thick in which there is insufficient fine-earth to fill more than half the interstices between clasts, with an upper boundary within 60 cm of the mineral soil surface.

**Stony-tailings Fill Anthropic Soils**

**AFT** Other soils.

**Typic Fill Anthropic Soils**

# Brown Soils

### CONCEPT OF THE ORDER

Brown Soils usually contain 2:1 clay minerals. Secondary iron oxides tend to be evenly dispersed through the soil and give a yellowish brown colour to the upper part of the B horizon. Base saturation values are usually moderate to very low.

### CORRELATION

The order comprises moderately and weakly weathered yellow-brown earths, yellow-brown sands, southern brown-granular loams and clays, and intergrades from yellow-brown earths to yellow-grey earths, podzols, brown-granular soils, and recent soils, as well as associated steepland soils of the NZ Genetic Soil Classification. The soils predominantly correlate with the Inceptisolsof Soil Taxonomy, excluding the suborder of Aquepts.

### OCCURRENCE

Brown Soils occur in places in which summer dryness is uncommon and that are not waterlogged in winter. They are the most extensive soil order in New Zealand

### ACCESSORY PROPERTIES OF THE ORDER

1. *Dispersed secondary oxides*. Secondary iron and aluminium oxides are dispersed throughout the soil mass. The soil is brunified (i.e. iron and aluminium oxides form coatings around phyllosilicate clay particles and form bridges between these particles and humus). P retention is moderate to very high.
2. *Low to moderate base saturation*. Base saturation values in subsoils are usually less than 50%, and KCl-extractable aluminium levels are usually more than 1.5 cmolc/kg except where clay contents are relatively low.
3. *Parent materials are mostly weakly weathered*. Mafic Brown Soils are derived from weakly weathered intermediate or mafic igneous rocks (e.g. phonolite and basalt). Other groups are derived dominantly from felsic quartzo-feldspathic sedimentary rocks (schist and greywacke) or felsic igneous rocks (e.g. rhyolites and granites). The alteration status of coarse rock fragments or hard rock substrates is usually fresh to moderately weathered and occasionally highly weathered.
4. *Mica/illite and vermiculite are common clay minerals*. Profiles tend to be mineralogically uniform with depth. Brown soils cover a wide range of mineralogy classes. Mixed, Illitic, Vermiculitic and Clay-mineralic (involving vermiculite and mica-vermiculite) are common. Some Allophanic Brown Soils have an Amorphic mineralogy class.
5. *Good Drainage*. No poorly drained or very poorly drained soils are included. Macroporosity is generally moderate (10–14%) except in subsurface horizons of Firm Brown Soils.
6. *Biologically active*. Except in soils that are limited by coldness or acidity. Spheroidal peds (e.g., worm casts) are common in topsoils and C/N ratios are moderate to low. The roots of native plants penetrate deeply.
7. *Relatively stable topsoils*. Aggregates are not readily dispersed.
8. *Moist climate or low available-water capacity*. Most soils occur in areas with mean annual precipitation of more than 1000 mm. Others have low available-water capacity , or are in sites with low evapotranspiration.

### SUMMARY OF BROWN SOILS HIERARCHY

|  |  |  |
| --- | --- | --- |
| Group | Subgroup | Example of series |
| **BL**  Allophanic | Mottled | - |
|  | Acidic | Tekoa |
|  | Firm | Te Anau |
|  | Acidic-mafic | Stewart |
|  | Typic | Craigieburn |
|  | Acidic-pedal | Kaiuma |
|  | Pedal | Levin |

|  |  |  |  |
| --- | --- | --- | --- |
| **BS**  Sandy | | Mottled-Placic | - |
|  | | Mottled | Awahou |
|  | | Acidic | Koputaroa |
|  | | Pallic | pt. Halkett |
|  | | Pan | ToeToes |
|  | | Typic | Foxton |
| **BX**  Oxidic | | Typic | - |
| **BM**  Mafic | | Mottled-magnesic | Croisilles var. |
|  | | Magnesic | pt. Dun |
|  |  | Mottled | - |
|  |  | Acidic | Cargill |
|  |  | Typic | Pipikaretu |
| **BA** | Acid | Peaty | pt. Spenser |
|  |  | Mottled-placic | Lammerlaw |
|  |  | Mottled | Mackley |
|  |  | Placic | pt. Tautuku |
|  |  | Pan | Whiterig |
|  |  | Typic | Carrick |
| **BF** | Firm | Mottled-acidic | - |
|  |  | Mottled-cemented | Harwarden |
|  |  | Mottled-weathered | - |
|  |  | Mottled-pallic | - |
|  |  | Mottled | Mahinerangi |
|  |  | Acidic-cemented | Whiterig |
|  |  | Cemented | Steward |
|  |  | Acidic-allophanic | Judgeford |
|  |  | Allophanic | Belmont |
|  |  | Weathered | - |
|  |  | Pallic | Pinelheugh |
|  |  | Acidic | Porteous |
|  |  | Typic | Waikiwi |
| **BO** | Orthic | Mottled - weathered | - |
|  |  | Mottled-acidic | - |
|  |  | Mottled | - |
|  |  | Humose | Pukaki |
|  |  | Immature | Grassmere |
|  |  | Pallic | - |
|  |  | Acidic | Pelorus |
|  |  | Weathered | - |
|  |  | Calcareous | - |
|  |  | Typic | Ruahine |

### KEY TO GROUPS OF BROWN SOILS

**BL** Brown soils that have within the B or BC horizon a subhorizon that meets the requirements of allophanic soil material but not necessarily the requirement for bulk density, and that is 10 cm or more thick and occurs with its upper surface at 60 cm or less from the mineral soil surface.

**ALLOPHANIC BROWN SOILS**

**BS** Other Brown Soils that from the base of the A horizon to 60 cm from the mineral soil surface, have sand or loamy sand texture and less than 35% coarse rock fragments (by volume), in all horizons (except for sandy loam laminations that do not meet the requirements of an argillic horizon).

**SANDY BROWN SOILS**

**BX** Other Brown Soils that in some part of the B horizon within 60 cm of the mineral soil surface, have

1. matrix colour value 4 or less, *and*
2. friable or very friable unconfined failure from very moist to dry, *and*
3. fine or finer polyhedral peds.

**OXIDIC BROWN SOILS**

**BM** Other Brown Soils that, in a subhorizon of the B or BC at 60 cm from the mineral soil surface, or at the base of the B or BC if shallower, have

1. matrix colour value 4 or less and moderately or strongly pedal polyhedral peds (20 mm or less in size), *or*
2. 5% (by volume) or more coarse rock fragments that consists mainly of mafic or ultramafic rocks (but not tuffaceous greywacke), *or*
3. an exchangeable calcium/magnesium ratio of 0.2 or less and exchangeable magnesium of 1.5 cmolc/kg or more.

**MAFIC BROWN SOILS**

**BA** Other Brown Soils that have *a* pH of 4.8 or less in some part between 20 and 60 cm from the mineral soil surface

**ACID BROWN SOILS**

**BF** Other Brown Soils that have a fragipan, or an apedal subhorizon with a slightly firm or stronger moist soil strength in the B or BC horizon, with an upper boundary within 90 cm of the mineral soil surface.

**FIRM BROWN SOILS**

**BO** Other Brown Soils.

**ORTHIC BROWN SOILS**

### KEY TO SUBGROUPS OF BROWN SOILS

**BL** ALLOPHANIC BROWN SOILS

Allophanic Brown Soils occur in soils that have a horizon with properties dominated by the presence of minerals with short-range order and aluminium-humus complexes. Such horizons are weak in strength, sensitive, and have low bulk density. They occur in quartzo-feldspathic and tuffaceous (greywacke) sandstone and argillite, and in volcanic-ash parent materials.

**BLM** Allophanic Brown Soils that have a mottled profile form or perch-gley features.

**Mottled Allophanic Brown Soils**

**BLP** Other soils that have a placic horizon.

**Placic Allophanic Brown Soils**

**BLA** Other soils that have, in some part[[1]](#footnote-3) of the B or BC horizon to 60 cm from the mineral soil surface, *both*

1. crumb (or earthy) structure, or bulk density of the fine-earth fraction less than 1.1 Mg/m3 with weakly pedal or apedal fabric, *and*
2. pH less than 5.5.

**Acidic Allophanic Brown Soils**

**BLF** Other soils that have *both*

1. in some part of the B horizon to 60 cm from the mineral soil surface, crumb (or earthy) structure, or bulk density of the fine-earth fraction less than 1.1 Mg/m3, *and*
2. an underlying layer that meets the requirements of a fragipan except for pedality, or an apedal subhorizon with a slightly firm or stronger moist soil strength, with an upper boundary within 90 cm of the mineral soil surface.

**Firm Allophanic Brown Soils**

|  |  |
| --- | --- |
| **BLT** | Other soils that have, in some part of the B or BC horizon to 60 cm depth from the mineral soil surface, crumb (or earthy) structure, or bulk density of the fine-earth fraction less than 1.1 Mg/m3 with weakly pedal or apedal fabric.  **Typic Allophanic Brown Soils** |

**BLAD** Other soils that have pH less than 5.5 in some part of the B or BC horizon at 60 cm or less from the mineral soil surface.

**Acidic-pedal Allophanic Brown Soils**

**BLD** Other soils.

**Pedal Allophanic Brown Soils**

**BS** SANDY BROWN SOILS

Sandy Brown Soils occur in sand deposits which are usually of aeolian origin, but may also be of alluvial origin. Subsurface horizons are sand or loamy sand.

**BSMP** Sandy Brown Soils that have a mottled profile form or perch-gley features and a placic horizon

**Mottled-placic Sandy Brown Soils**

|  |  |
| --- | --- |
| **BSM** | Other soils that have a mottled profile form or perch-gley features.  **Mottled Sandy Brown Soils** |
| **BSA** | Other soils that have pH less than 5.5 in some part of the B or BC horizon, to its base, or to 60 cm from the mineral soil surface (whichever is shallower).  **Acidic Sandy Brown Soils** |
| **BSP** | Other soils that have *either*   1. an argillic horizon composed of lamellae, *or* 2. an eluvial horizon, or skeletans as apparent segregations of relatively higher colour value in B or BC horizons (“two-tone”).   **Pallic Sandy Brown Soils** |
| **BSX** | Other soils that have either a placic horizon or ortstein-pan  **Pan Sandy Brown Soils** |
| **BST** | Other soils.  **Typic Sandy Brown Soils** |
| **BX** OXIDIC BROWN SOILS  Oxidic Brown Soils occur in strongly weathered soil materials similar to those of Oxidic Soils except that Oxidic Brown Soils are less weatheredand thus havemore reserve magnesium. They usually occur in association with Oxidic Soils, Ultic Soils or Granular Soils but on younger land surfaces.  **BXT** Oxidic Brown Soils (only one subgroup).  **Typic Oxidic Brown Soils**  **BM** MAFIC BROWN SOILS  Mafic Brown Soils occur in soil materials weathered from ultramafic, mafic or intermediate igneous rocks or tuffs. They have relatively high proportions of dark magnesium and iron-rich (mafic) silicate minerals, and have relatively large contents of iron oxides. | |

**BMMG** Mafic Brown Soils that have *both*

1. a mottled profile form or perch-gley features, *and*
2. either
   1. 5% (by volume) or more coarse rock fragments consisting mainly of ultramafic rocks, or
   2. have an exchangeable calcium/magnesium molar ratio of 0.2 or less in some part of the B or BC horizon to 60 cm from the mineral soil surface.

**Mottled-magnesic Mafic Brown Soils**

**BMG** Other soils that have *either*

1. 5% (by volume) or more coarse rock fragments consisting mainly of ultramafic rocks, *or*
2. have an exchangeable calcium/magnesium molar ratio of 0.2 or less in some part of the B or BC horizon to 60 cm from the mineral soil surface.

**Magnesic Mafic Brown Soils**

**BMM** Other soils that have a mottled profile form or perch-gley features.

**Mottled Mafic Brown Soils**

**BMA** Other soils that have pH less than 5.5 in some part of the B or BC horizon to 60 cm from the mineral soil surface.

**Acidic Mafic Brown Soils**

**BMT** Other soils.

**Typic Mafic Brown Soils**

**BA** ACID BROWN SOILS

Acid Brown Soils are strongly or extremely acidic soils, many of which occur in very moist or cold mountain environments. Many have a placic horizon.

**BAO** Acid Brown Soils that have a peaty topsoil.

**Peaty Acid Brown Soils**

**BAMP** Acid Brown Soils that have *both*

1. a placic horizon or ortstein-pan at 60 cm or less from the mineral soil surface, *and*
2. a mottled profile form or perch-gley features.

**Mottled-impeded Acid Brown Soils**

**BAM** Other soils that have a mottled profile form or perch-gley features.

**Mottled Acid Brown Soils**

**BAX** Other soils that in the B have a subhorizon, that meets the strength requirements of an ortstein‑pan, within 90 cm of the mineral soil surface.

**Pan Acid Brown Soils**

**BAP** Other soils with a placic horizon.

**Placic Acid Brown Soils**

**BAT** Other soils.

**Typic Acid Brown Soils**

**BF** FIRM BROWN SOILS

Firm Brown Soils have an apedal subsurface horizon with slightly firm or stronger moist soil strength which shares some of the characteristics of a fragipan or an ortstein-pan. The soils occur on relatively stable sites and are most commonly on flat, rolling or moderately hilly slopes.

**BFMA** Firm Brown Soils that have *both*

1. a mottled profile from or perch-gley features, *and*
2. pH less than 5.5 in some part between the base of the A horizon and within 60 cm of the mineral soil surface.

**Mottled-acidic Firm Brown Soils**

**BFMC** Other soils that have *both*

1. a mottled profile form or perch-gley features, *and*
2. a horizon that is cemented to the degree that it is at least weakly indurated, within 90 cm of the mineral soil surface.

**Mottled-cemented Firm Brown Soils**

**BFMW** Other soils that have *both*

1. a mottled profile form or perch-gley features, and
2. clasts that in the majority are weathered to the extent that rock fragments may easily be broken by hammer or spade.

**Mottled-weathered Firm Brown Soils**

**BFMP** Other soils that have *both*

1. a mottled profile form or perch-gley features, and
2. that have in some part of the B or BC horizon to 90cm in from the mineral soil surface, either matrix hue of 2.5Y or yellower or matrix hue of 10YR and chroma 4 or less with either
   1. non-reactive, very weak or weak reactive-aluminium test, or
   2. a cutanic horizon, or
   3. P retention less than 30%.

**Mottled-pallic Firm Brown Soils**

**BFM** Other Soils that have a mottled profile form or perch-gley features.

**Mottled Firm Brown Soils**

**BFCA** Other soils have *both*

1. pH less than 5.5 in some part between the base of the A horizon and within 60 cm of the mineral soil surface, *and*
2. a horizon that is cemented to the degree that it is at least weakly indurated, within 90 cm of the mineral soil surface.

**Acidic-cemented Firm Brown Soils**

**BFC** Other soils that have a horizon that is cemented to the degree that it is at least weakly indurated, within 90 cm of the mineral soil surface.

**Cemented Firm Brown Soils**

**BFLA** Other soils that have in some part of the B or BC horizon to 90 cm or less from the mineral soil surface *both*

1. P retention 85% or more, or strong or very strong reactive-aluminium test, and
2. pH of less than 5.5.

**Acidic-allophanic Firm Brown Soils**

**BFL**  Other soils that have P retention 85% or more, or strong or very strong reactive-aluminium test, in some part of the B or BC horizon to 90 cm or less from the mineral soil surface.

**Allophanic Firm Brown Soils**

**BFF**

Other soils that have a placic horizon.

**Placic Firm Brown Soils**

**BFWA** Other soils that have *both*

1. in the B or BC horizon to 90 cm or less from the mineral soil surface the majority of the coarse rock fragments is weathered to the extent that coarse rock fragments may easily be broken by hammer or spade, and
2. a pH of less than 5.5 within 60 cm of the mineral soil surface in some part of the B or BC horizon.

**Acidic-weathered Firm Brown Soils**

**BFW**  Other soils in which the majority of the coarse rock fragments is weathered to the extent that clasts may easily be broken by hammer or spade.

**Weathered Firm Brown Soils**

**BFPA** Other soils that have in some part of the B or BC horizon to 90 cm from the mineral soil surface, *either*

1. matrix hue of 2.5Y or yellower, or
2. matrix hue of 10YR and chroma 4 or less with either

(a) non-reactive, very weak or weak reactive-aluminium test, *or*

(b) a cutanic horizon, *or*

(c) P retention less than 30%.

AND

a pH of less than 5.5 within 60 cm of the mineral soil surface in some part of the B or BC horizon.

**Acidic-pallic Firm Brown Soils**

**BFP** Other soils that have in some part of the B or BC horizon to 90 cm from the mineral soil surface, *either*

1. matrix hue of 2.5Y or yellower, or
2. matrix hue of 10YR and chroma 4 or less with either

(a) non-reactive, very weak or weak reactive-aluminium test, *or*

(b) a cutanic horizon, *or*

(c) P retention less than 30%.

**Pallic Firm Brown Soils**

**BFA** Other soils that have in some part of the B horizon above the apedal horizon with a slightly firm or stronger strength class, *either*

1. pH less than 5.5, *or*
2. a subhorizon with 10% or more humus or humus-clay coatings of moist colour value 4 or less or colour value 5 and chroma 3.

**Acidic Firm Brown Soils**

**BFT** Other soils.

**Typic Firm Brown Soils**

**BO** ORTHIC BROWN SOILS

Orthic Brown Soils have B horizon peds or have weak or very weak soil strength to depth. They most commonly occur on hilly or steep slopes, or on Holocene land surfaces.

**BOMW** Orthic Brown Soils that have *both*

1. a mottled profile form or perch-gley features, *and*
2. clasts that in the majority is weathered to the extent that rock fragments may easily be broken by hammer or spade

**Mottled-weathered Orthic Brown Soils**

**BOMP** Other soils that have *both*

1. a mottled profile form or perch-gley features, and
2. that have in some part of the B or BC horizon to 90cm in from the mineral soil surface, either matrix hue of 2.5Y or yellower or matrix hue of 10YR and chroma 4 or less with either
   1. non-reactive, very weak or weak reactive-aluminium test, or
   2. a cutanic horizon, or
   3. P retention less than 30%.

**Mottled-pallic Orthic Brown Soils**

**BOMA** Other soils that have *both*

1. a mottled profile form or perch-gley features, *and*
2. pH less than 5.5 in some part between the base of the A horizon and within 60 cm of the mineral soil surface.

**Mottled-acidic Orthic Brown Soils**

**BOM** Other soils that have a mottled profile form or perch-gley features.

**Mottled Orthic Brown Soils**

|  |  |
| --- | --- |
| **BOH** | Other soils that have *both*   1. colour value of the matrix 4 or less and hue 2.5Y or redder, or 10% or more coatings of colour value 4 or less in the greater part of the B horizon, *and* 2. 10% or less clay within 90 cm of the mineral soil surface   **Humose Orthic Brown Soils** |
| **BOI** | Other soils that have *either*   1. a buried A horizon within 120 cm of the mineral soil surface, *or* 2. a weathered-B horizon 30 cm or less thick that, throughout,    1. has chroma less than 6, and    2. is either apedal massive or apedal single-grain and has weak or very weak moist soil strength.   **Immature Orthic Brown Soils** |
| **BOP** | Other soils that have in some part of the B or BC horizon within 90 cm from the mineral soil surface *either*   1. matrix hue of 2.5Y or yellower, *or* 2. matrix hue of 10YR and chroma 4 or less with either    1. non-reactive, very weak or weak reactive-aluminium   test, or   * 1. a cutanic horizon, or   2. P retention less than 30%.   **Pallic Orthic Brown Soils** |
|  | **BOWA** Other soils  1. that contain coarse rock fragments that in the majority are weathered to the extent that clasts may easily be broken by hammer or spade and |

2. that have a pH of less than 5.5 within 60 cm of the mineral soil surface in some part of the B or BC horizon.**Acidic Weathered Orthic Brown Soils BOW** Other soils with coarse rock fragments that in the majority is weathered to the extent that clasts may easily be broken by hammer or spade

**Weathered Orthic Brown Soils**

|  |  |
| --- | --- |
| **BOA** | Other soils that have pH less than 5.5 in some part of the B or BC horizon to 60 cm from the mineral soil surface.  **Acidic Orthic Brown Soils** |

**BOC** Other soils that have in part of the B horizon a calcareous horizon within 60 cm of the mineral soil surface.

**Calcareous Orthic Brown Soils**

**BOT**  Other soils.

**Typic Orthic Brown Soils**

# Gley Soils

### CONCEPT OF THE ORDER

Gley Soils are poorly-drained and very poorly-drained soils. In their undrained state, saturation occurs during prolonged periods, oxygen is limited and reducing conditions occur (typically affecting iron, manganese, nitrates, and sometimes sulphates). Greyish colours are dominant throughout the solum or to a depth of 90 cm or more.

### CORRELATION

The order comprises gley soils and gleyed recent soils of the NZ Genetic Soil Classification. The soils correlate predominantly with soils exhibiting aquic conditions in Soil Taxonomy, particularly the suborders Aquents, Aquepts, Aquults, and Aquox.

### OCCURRENCE

Gley Soils occur throughout New Zealand, usually 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.

### ACCESSORY PROPERTIES OF THE ORDER

1. *Segregation of iron and manganese oxides.* Particles in reduced parts of the soil are not coated by secondary oxides. Redox segregations of iron and manganese oxides, however, are usually present elsewhere in the soil and may occupy large volumes.
2. *Commonly formed in alluvial or colluvial parent materials*. Soils most frequently occur in relatively low parts of the landscape, in hollows or associated with flushes.
3. *Wide range of clay minerals*. The clay mineralogy commonly reflects the mineralogy of the ungleyed material from which the soils are derived. Gley Soils cover a wide range of mineralogy classes with Mixed, Illitic, and Smectitic being the most common.
4. *Poorly or very poorly drained*. Topsoils have relatively high levels of organic matter and some are peaty. Subsurface horizons to depth are dominantly grey or bluish grey in colour with strong brown to dark brown redox segregations.
5. *High groundwater-tables*. Most are affected by high groundwater-tables, at least throughout winter months. Soils with slowly permeable layers may also be subject to perching.
6. *Shallow potential rooting depth*. Potential rooting depth is limited by poor aeration. Even after drainage, root extension may be limited in some horizons.
7. *Relatively high bulk densities*. Bulk densities are likely to be higher than in well drained soils in similar soil materials.
8. *Limited trafficability*. Trafficability is limited in most soils when wet and pugging damage by stock is likely.
9. *Response to drainage*. Crops, not adapted to wetness, respond well to drainage.
10. *Minimal erosion*. Flooding or ponding of water is likely on low-lying sites, especially on floodplains. Deposition of fresh sediment is possible in these sites.
11. *Nitrogen requirement*. Nitrogen requirements are likely to be higher than for associated well drained soils.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Group | | Subgroup | Example of series | |
| **GU** | Sulphuric | Fluid-saline | pt. Takahiwai | |
|  |  | Fluid | pt. Takahiwai | |
|  |  | Peaty | Te Kowiwi | |
|  |  | Sandy-saline | Muriwai | |
|  |  | Typic | - | |
| **GT** | Tephric | Peaty | - | |
|  |  | Acidic | - | |
|  |  | Typic | - | |
| **GS** | Sandy | Peaty | - | |
|  |  | Saline | - | |
|  |  | Concretionary | Carnarvon | |
|  |  | Acidic | Berwick | |
|  |  | Typic | Pukepuke | |
| **GX** | Oxidic | Nodular | pt. Kapiro | |
|  | Typic |  | pt. Waipapa | |
| **GR** | Recent | Peaty | Kakawa | |
|  |  | Fluid | - | |
|  |  | Saline | Pāuatahanui | |
|  |  | Calcareous | Ahuriri | |
| **GA**  Acid | | Peaty | - |
|  | | Granular | Te Hihi |
|  | | Ultic | pt. Waikare |
|  | | Placic-humose | pt. Flagstaff |
|  | | Humose | pt. Flagstaff |
|  | | Typic | Dacre |
|  | | Acidic | Virgin |
|  | | Typic | Hastings |
| **GO**  Orthic | | Peaty | Waimairi |
|  | | Saline | - |
|  | | Calcareous | Wainui |
|  | | Ironstone | Okato |
|  | | Melanic | Netherton |
|  | | Argillic | pt. Waterton |
|  | | Acidic | Bidois |
|  | | Typic | Invermay |

### KEY TO GROUPS OF GLEY SOILS

**GU** Gley Soils that within 60 cm of the mineral soil surface have *both*

1. a horizon with pH less than 4.8, *and*
2. either straw-yellow jarosite mottles or moderately fluid or very fluid fluidity class.

**SULPHURIC GLEY SOILS**

**GT** Other Gley Soils in tephric soil material from the mineral soil surface to 30 cm depth or more

**TEPHRIC GLEY SOILS**

**GS** Other Gley Soils that have a sand or loamy sand texture, and less than 35% (by volume) coarse rock fragments, in all horizons from the base of the A horizon to 60 cm from the mineral soil surface.

**SANDY GLEY SOILS**

**GX** Other Gley Soils that have an oxidic horizon more than 30 cm thick with an upper boundary between 20 and 60 cm from the mineral soil surface.

**OXIDIC GLEY SOILS**

**GR** Other Gley Soils that have

1. either of the following
   1. fine sedimentary stratification at 60 cm or less, or
   2. a buried A horizon with its upper surface deeper than 30 cm but within 120 cm of the mineral soil surface, or some other indication of an irregular carbon profile such as sedimentary plant leaf material, *and*
2. have none of the following
   1. a buried B horizon with an upper surface at 60 cm or less from the mineral soil surface, *nor*
   2. a B or BC horizon with base deeper than 30 cm from the mineral soil surface, *nor*
   3. a placic horizon nor ortstein-pan, *nor*
   4. a horizon with more than 2% concretions or nodules coarser than sand size within 60 cm of the mineral soil surface.

**RECENT GLEY SOILS**

**GA** Other Gley Soils that have pH of 4.8 or less in some part between 20 and 60 cm from the mineral soil surface.

**ACID GLEY SOILS**

**GO** Other Gley Soils.

**ORTHIC GLEY SOILS**

### KEY TO SUBGROUPS OF GLEY SOILS

**GU** SULPHURIC GLEY SOILS

Sulphuric Gley Soils occur in marine estuarine sites in which sufficient oxidation of ferrous sulphides has occurred to produce either sulphuric acid, or the mineral jarosite, or both.

**GUFQ** Sulphuric Gley Soils that within 60 cm of the mineral soil surface have *both*

1. moderately fluid or very fluid fluidity class, *and*
2. saline soil materials.

**Fluid-saline Sulphuric Gley Soils**

**GUF** Other soils that within 60 cm of the mineral soil surface have moderately fluid or very fluid fluidity class.

**Fluid Sulphuric Gley Soils**

**GUO** Other soils that have a peaty topsoil either at the surface or buried with its upper surface within 60 cm of the soil surface.

**Peaty Sulphuric Gley Soils**

**GUSQ** Other soils that are sandy by weighted average to 90 cm from the mineral soil surface and have saline soil materials within 60 cm of the mineral soil surface.

**Sandy-saline Sulphuric Gley Soils**

|  |  |
| --- | --- |
| **GUT** | Other soils  **Typic Sulphuric Gley Soils** |
| **GT** TEPHRIC GLEY SOILS | |
| Tephric Gley Soils occur in unconsolidated sediment of volcanic origin including ash, cinders, lapilli, pumice and other pyroclastics. | |
| **GTO** | Tephric Gley Soils that have a peaty topsoil either at the surface or buried with its upper surface within 60 cm of the soil surface.  **Peaty Tephric Gley Soils** |
| **GTA** | Other soils that have pH of less than 5.5 in some part from the base of the A horizon to 60 cm from the mineral soil surface.  **Acidic Tephric Gley Soils** |
| **GTT** | Other soils |

**Typic Tephric Gley Soils**

**GS** SANDY GLEY SOILS

Sandy Gley Soils occur in sand deposits which are usually aeolian, but may also be of alluvial origin. Subsurface horizons are sand or loamy sand.

|  |  |
| --- | --- |
| **GSO** | Sandy Gley Soils that have a peaty topsoil either at the surface or buried with its upper surface within 60 cm of the mineral soil surface.  **Peaty Sandy Gley Soils** |
| **GSQ** | Other soils that within 60 cm of the mineral soil surface have saline soil materials.  **Saline Sandy Gley Soils** |
| **GSC** | Other soils that have more than 2% concretions in some horizon at a depth of 60 cm or less from the mineral soil surface.  **Concretionary Sandy Gley Soils** |
| **GSA** | Other soils that have pH of less than 5.5 in some part from the base of the A horizon to 60 cm from the mineral soil surface |

**Acidic Sandy Gley Soils**

**GST** Other soils.

**Typic Sandy Gley Soils**

**GX** OXIDIC GLEY SOILS

Oxidic Gley Soils have variable charge properties and contain low-activity clays. The mineralogy is dominated by kaolin group clay minerals. Iron oxides are less common than in the Oxidic Soils.

**GXN** Oxidic Gley Soils that have a nodular horizon with an upper boundary within 60 cm of the mineral soil surface.

**Nodular Oxidic Gley Soils**

**GXT** Other soils.

**Typic Oxidic Gley Soils**

**GR** RECENT GLEY SOILS

Recent Gley Soils occur on young land surfaces, usually in fluvial or estuarine sediments. In many sites there is a significant flood risk.

|  |  |
| --- | --- |
| **GRO** | Recent Gley Soils that have a peaty topsoil either at the surface or buried with its upper surface within 60 cm of the soil surface.  **Peaty Recent Gley Soils** |
| **GRF** | Other soils that within 60 cm of the mineral soil surface have moderately fluid or very fluid fluidity class  **Fluid Recent Gley Soils** |
| **GRQ** | Other soils that within 60 cm of the mineral soil surface have saline soil materials.  **Saline Recent Gley Soils** |
| **GRC** | Other soils that have a calcareous horizon or a shelly layer within 60 cm of the mineral soil surface.  **Calcareous Recent Gley Soils** |
| **GRA** | Other soils that have pH less than 5.5 in some part from the base of the A horizon to 60 cm of the mineral soil surface.  **Acidic Recent Gley Soils** |
| **GRT** | Other soils. |

**Typic Recent Gley Soils**

**GA** ACID GLEY SOILS

Acid Gley Soils occur on relatively stable land surfaces, and have been subject to a fluctuating groundwater-table, or a deep layer of perched water. Plants grown are susceptible to aluminium toxicity.

**GAO** Acid Gley Soils that have a peaty topsoil at the surface or buried within 60 cm of the surface.

**Peaty Acid Gley Soils**

**GAG** Other soils that have a clayey, moderately or strongly pedal cutanic or argillic horizon and polyhedral peds 20 mm or less in the major part of the B horizon to 60 cm of the mineral soil surface.

**Granular acid Gley Soils**

**GAY** Other soils that have a B horizon which has in the major part, *both*

1. 10% or more clay or humus coatings on ped faces, *and*
2. less silt than clay.

**Ultic Acid Gley Soils**

**GAPH** Other soils that have both a placic horizon and a B horizon with 10% or more dark-coloured coats on ped faces, in pores or on coarse rock fragments, with moist colour value 4 or less or colour value 5 and chroma 3.

**Placic-humose Acid Gley Soils**

**GAH** Other soils that have a B horizon with 10% or more dark-coloured coats on ped faces, in pores or on coarse rock fragments, with moist colour value 4 or less or colour value 5 and chroma 3.

**Humose Acid Gley Soils**

**GAT** Other soils.

**Typic Acid Gley Soils**

**GO** ORTHIC GLEY SOILS

Orthic Gley Soils occur on relatively stable land surfaces in sites affected by groundwater. Sediment deposition is unlikely if flooding occurs. They are neither strongly acidic, sandy nor sulphuric and have no oxidic horizon.

**GOO** Orthic Gley Soils that have a peaty topsoil either at the surface or buried with its upper surface within 60 cm of the soil surface.

**Peaty Orthic Gley Soils**

**GOQ** Other soils that within 60 cm of the mineral soil surface have saline soil materials.

**Saline Orthic Gley Soils**

**GOC** Other soils that have a calcareous horizon at 60 cm or less from the mineral soil surface.

**Calcareous Orthic Gley Soils**

**GOI** Other soils that have an ironstonepan at 90 cm depth or less from the mineral soil surface.

**Ironstone Orthic Gley Soils**

**GOE** Other soils that have a B horizon, in which the major part to 60 cm from the mineral soil surface or to its base (whichever is less)

1. has moderate or strong pedality, and

2. is moderately sticky or very sticky, and

3. has pH of 5.9 or more.

**Melanic Orthic Gley Soils**

**GOJ** Other soils that have an argillic horizon.

**Argillic Orthic Gley Soils**

**GOA** Other soils that have pH of less than 5.5 in some part from the base of the A horizon to 60 cm from the mineral soil surface.

**Acidic Orthic Gley Soils**

**GOT** Other soils.

**Typic Orthic Gley Soils**

# Granular Soils

### CONCEPT OF THE ORDER

Granular soils are clayey soils in which kaolin-group minerals are dominant, and are usually associated with vermiculite and hydrous-interlayered vermiculite. The soil fabric comprises polyhedral peds with strength characteristics which change rapidly with water content. Consistence is sticky and plastic. The presence of vermiculite gives these soils a moderate buffer capacity. The soils lack the weak strength, friable failure, low plasticity, and low-activity-clay properties which either define or are accessory to Oxidic Soils. Clay coatings where they occur are thin.

### CORRELATION

The order comprises many soils previously classified as brown granular loams and moderately to strongly leached brown granular clays of the NZ Genetic Soil Classification. Most are correlated with the Ultisols and Alfisols of Soil Taxonomy.

### OCCURRENCE

Granular Soils are only known to occur in the northern North Island, particularly in the lowlands of the Waikato and South Auckland regions.

### ACCESSORY PROPERTIES OF THE ORDER

1. *Moderate activity clay*. CEC is greater than 16 cmolc/kg (clay) and ECEC ranges from about 8 to 16 cmolc/kg (clay).
2. *Parent materials*. The soils are derived predominantly from strongly weathered tephras mostly older than 50 000 years, but also from basaltic and andesitic rocks with possible additions from aeolian material.
3. *Kandic mineralogy.* Granular Soils usually belong to the Kandic mineralogy class.
4. *Slowly permeable*. Saturated hydraulic conductivity is slow or marginally slow somewhere in the profile, resulting in periods of perching of water.
5. *Limited root depth*. The extension of plant roots in subsoils is commonly limited by either high penetration resistance, wetness or aluminium toxicity.
6. *Limited workability when wet.* Workability and trafficability is constrained by stickiness and plasticity after heavy rainfall, particularly in contrast to Oxidic Soils.
7. *Low phosphorus status*. Phosphorus fixation may be high, as indicated by high P retention levels.
8. *Strongly weathered with low nutrient reserves*. Reserves of phosphorus, potassium and magnesium are low, particularly in the Oxidic group.
9. *Sulphate in B horizons*. Sulphate tends to be strongly adsorbed in B horizons.

### SUMMARY OF GRANULAR SOILS HIERARCHY

|  |  |  |  |
| --- | --- | --- | --- |
| Group | | Subgroup | Example of series |
| **NP** | Perch-gley | Oxidic | Rangiuru var. |
|  |  | Acidic | Tutamoe |
|  |  | Typic | Kohumaru |
| **NE** | Melanic | Mottled | - |
|  |  | Allophanic | pt. Morrinsville |
|  |  | Typic | Morrinsville |
| **NX** | Oxidic | Mottled-acidic | Awarua var. |
|  |  | Mottled | pt. Waimatenui |
|  |  | Allophanic | pt. Naike |
|  |  | Acidic | Awarua |
|  |  | Typic | Naike |
| **NO** | Orthic | Mottled-acidic | Waipoua var. |
|  |  | Mottled | pt. Hamilton |
|  |  | Allophanic | - |
|  |  | Acidic | Waipoua |
|  |  | Typic | Hamilton |

### KEY TO GROUPS OF GRANULAR SOILS

**NP** Granular soils that have *both*

1. a gley profile form, *and*

2. perch-gley features.

**PERCH-GLEY GRANULAR SOILS**

**NE** Other Granular soils that have pH of 5.9 or more in the major part of the B horizon to 60 cm from the mineral soil surface.

**MELANIC GRANULAR SOILS**

**NX** Other Granular soils that have a cutanoxidic horizon more than 30 cm thick with an upper boundary at 25 cm or more from the mineral soil surface.

**OXIDIC GRANULAR SOILS**

**NO** Other Granular soils.

**ORTIC GRANULAR SOILS**

### KEY TO SUBGROUPS OF GRANULAR SOILS

**NP** PERCH-GLEY GRANULAR SOILS

Perch-gley Granular Soils occur in sites that are periodically saturated (if undrained). Wetness and associated reducing conditions are indicated by grey colours and reddish mottles. The wetness is caused by perching of water on a clay-enriched slowly permeable layer, although a groundwater-table may also be present.

**NPX** Perch-gley Granular Soils that have a cutanoxidic horizon more than 30 cm thick with an upper boundary below 25 cm from the mineral soil surface.

**Oxidic Perch-gley Granular Soils**

**NPA** Other soils that have pH 5.1 or less in some part of the B or BC horizon to 60 cm from the mineral soil surface.

**Acidic Perch-gley Granular Soils**

**NPT** Other soils.

**Typic Perch-gley Granular Soils**

**NE** MELANIC GRANULAR SOILS

Melanic Granular Soils are less acidic and more fertile than other Granular Soils. Base saturation exceeds 50% in part of the root zone.

**NEM** Melanic Granular Soils that have a mottled profile form.

**Mottled Melanic Granular Soils**

**NEL** Soils that have a horizon that is 10 cm or more thick within 60 cm of the mineral soil surface that meets all the requirements of allophanic soil material, but not necessarily the requirement for bulk density.

**Allophanic Melanic Granular Soils**

**NET** Other soils.

**Typic Melanic Granular Soils**

**NX** OXIDIC GRANULAR SOILS

Oxidic Granular Soils have low ECEC (marginal to Oxidic Soils), have low fertility and are acidic. Some plants may be susceptible to aluminium toxicity.

**NXMA** Oxidic Granular Soils that have *both*

1. a mottled profile form, *and*
2. pH of less than 5.1 in some part of the B or BC horizon to 60 cm from the mineral soil surface.

**Mottled-acidic Oxidic Granular Soils**

|  |  |
| --- | --- |
| **NXM** | Other soils that have a mottled profile form.  **Mottled Oxidic Granular Soils** |
| **NXL** | Other soils that have a layer that meets the requirements of allophanic soil material except for bulk density, and is 10 cm or more thick, within 60 cm of the mineral soil surface.  **Allophanic Oxidic Granular Soils** |
| **NXA** | Other soils that have pH of less than 5.1 in some part of the B or BC horizon to 60 cm from the mineral soil surface.  **Acidic Oxidic Granular Soils** |
| **NXT** | Other soils. |

**Typic Oxidic Granular**

**NO** ORTHIC GRANULAR SOILS

Orthic Granular Soils are well, moderately well or imperfectly drained soils that are sticky or very plastic with clay-enriched B horizons. Their fertility is intermediate between Oxidic and Melanic groups.

**NOMA** Orthic Granular Soils that have *both*

1. a mottled profile form, *and*
2. pH of less than 5.1 in some part of the B or BC horizon to 60 cm from the mineral soil surface.

**Mottled-acidic Orthic Granular Soils**

**NOM** Other soils that have a mottled profile form.

**Mottled Orthic Granular Soils**

**NOL** Other soils that have a layer that meets the requirements of allophanic soil material except for bulk density, and is 10 cm or more thick within 60 cm of the mineral soil surface.

**Allophanic Orthic Granular Soils**

**NOA** Other soils that have pH of less than 5.1 in the major part of the B or BC horizon to 60 cm from the mineral soil surface.

**Acidic Orthic Granular Soils**

**NOT** Other soils.

**Typic Orthic Granular Soils**

# Melanic Soils

### CONCEPT OF THE ORDER

Melanic Soils are well structured soils with very dark A horizons. They commonly have high base saturation, combined with weakly alkaline or weakly acidic subsurface horizons, but more acidified and allophanic variants may exist under higher soil moisture regimes. Their parent materials are rich in calcium and/or magnesium.

### CORRELATION

The Melanic Soils include the rendzinas and rendzic intergrades to yellow-grey earths and yellow-brown earths. They also include the weakly weathered and drier brown-granular loams and clays of the NZ Genetic Soil Classification. Most commonly, these soils correlate with Mollisols, Vertisols or Inceptisols of Soil Taxonomy.

### OCCURRENCE

Melanic Soils are scattered throughout New Zealand in association with calcareous rocks or mafic and ultramafic rock classes.

### ACCESSORY PROPERTIES OF THE ORDER

1. *Swelling clays*. Most soils have smectite, or minerals with interstratifications of smectite, in the clay mineral assemblage. Melanic Soils usually have a Smectitic, Illitic or Kandic mineralogy class.
2. *High base saturations*. Except for acidified variants, base saturations are usually more than 50%, and KCl-extractable aluminium values are usually very low.
3. *Stable structure*. Structural stability of topsoils is high with relatively large amounts of organic carbon intimately associated with clay minerals. The soils are likely to have relatively high resistance to structural damage under heavy cropping unless organic matter is reduced significantly. The porosity is stabilised by divalent ion/organic matter/clay complexes.
4. *High shrink/swell*. The soil materials are sticky and plastic. They are expected to have significant shrink/swell potential, expressed in high coefficient of linear expandibility values. This is reflected in strong polyhedral, blocky or prismatic pedality. P retention values are moderate to high.
5. *Fertile*. Except for acidified variants, exchangeable calcium and magnesium values are high, particularly at the base of profile.
6. *Parent materials*. The soils are derived from calcareous, mafic or ultramafic rock classes.
7. *Deep rooting*. Except for shallow soils on rock or soils affected by high water-tables, potential rooting depths are relatively large.
8. *Biologically active*. Carbon/nitrogen ratios are low (except in areas with very high precipitation).

### SUMMARY OF MELANIC HIERARCHY

|  |  |  |  |
| --- | --- | --- | --- |
| Group | | Subgroup | Example of series |
| **EV** | Vertic | Mottled - calcareous | - |
|  |  | Mottled | pt. Waiareka |
|  |  | Calcareous | Te Aneraki |
|  |  | Typic | Waiareka |
| **EP** | Perch-gley | Vertic | Awapuni |
|  |  | Argillic | Okoia |
|  |  | Typic | - |
| **ER** | Rendzic | Peaty | Chalky |
|  |  | Mottled | - |
|  |  | Weathered | Te Matai |
|  |  | Typic | Oamaru |
| **EM** | Mafic | Magnesic | Dun |
|  |  | Mottled | pt.Awapuku |
|  |  | Typic | Rapaki |
| **EO** | Orthic | Mottled-calcareous | pt. Waikakahi |
|  |  | Argillic-calcareous | Kauana |
|  |  | Pedal-calcareous | pt. Waikakahi |
|  |  | Calcareous | pt. Pikikiruna |
|  |  | Mottled-argillic | - |
|  |  | Mottled | - |
|  |  | Argillic | Kaihiku |
|  |  | Typic | Bishopdale |

### KEY TO GROUPS OF MELANIC SOILS

**EV** Melanic Soils that have *both*

1. Either
   1. cracks at least 4 mm wide in some part, either in the B horizon infilled with A horizon material, or extending to a depth of 30 cm or more from the mineral soil surface, or
   2. coefficient of linear extensibility of 0.09 or more with moderate or strong blocky or prismatic pedality in the major part of the B horizon, *and*
2. No redox segregations within 30 cm of the mineral soil surface.

**VERTIC MELANIC SOILS**

**EP** Other soils that have *both*

1. a peaty topsoil or a gley profile form, *and*
2. perch-gley features.

**PERCH-GLEY MELANIC SOILS**

**ER** Other soils that have limestone or other calcareous material either in the form of a lithic or paralithic contact, or contain a high proportion of coarse rock fragments (70% or more by volume) in the form of rock rubble, with an upper boundary at 60 cm or less and which continues to more than 90 cm from the mineral soil surface.

**RENDZIC MELANIC SOILS**

**EM** Other soils that, in a subhorizon of the B or BC horizon at 60 cm from the mineral soil surface, or at the base of the B or BC if shallower, have

1. matrix colour value 4 or less and chroma 3 or more, *or*
2. 5% (by volume) or more coarse rock fragments that consist mainly of mafic or ultramafic rocks (but not tuffaceous greywacke), *or*
3. an exchangeable calcium/magnesium ratio of 0.2 or less and exchangeable magnesium of 1.5 cmolc/kg or more.

**MAFIC MELANIC SOILS**

**EO** Other soils.

**ORTHIC MELANIC SOILS**

### KEY TO SUBGROUPS OF MELANIC SOILS

|  |  |
| --- | --- |
| **EV** VERTIC MELANIC SOILS | |
|  | Vertic Melanic Soils occur in clayey soil materials dominated by clay minerals with high capacity to shrink on drying and swell on rewetting.  **EVMC** Vertic melanic soils that have *both*   1. redox segregations within 60 cm of the mineral soil surface, *and* 2. a calcareous horizon within 90 cm of the mineral soil surface   **Mottled-calcareous Melanic Soils**  **EVM** Other soils that have redox segregations within 60 cm of the mineral soil surface.  **Mottled Vertic Melanic Soils**  **EVC** Other soils with a calcareous horizon within 90 cm of the mineral soil surface.  **Calcareous Vertic Melanic Soils**  **EVT** Other soils.  **Typic Vertic Melanic Soils** |
| **EP** | PERCH-GLEY MELANIC SOILS |
|  | Perch-gley Melanic Soils occur in sites that are periodically saturated (unless artificially drained). Wetness and associated reducing conditions are indicated by grey colours in horizons subjacent to the topsoil, and are caused by perching of water on a slowly permeable subsurface layer, although a groundwater-table may also be present. |

**EPV** Perch-gley Melanic Soils that have *either*

1. cracks at least 4 mm wide in some part, either in the B horizon infilled with A horizon material, or extending to a depth of 30 cm or more from the mineral soil surface, *or*
2. coefficient of linear expandibility of 0.09 or more, with pedality that is moderate or strong and, blocky or prismatic in the major part of the B horizon.

**Vertic Perch-gley Melanic Soils**

**EPJ** Other soils with an argillic horizon.

**Argillic Perch-gley Melanic Soils**

**EPT** Other soils.

**Typic Perch-gley Melanic Soils**

**ER** RENDZIC MELANIC SOILS

Rendzic Melanic Soils occur in soils in which limestone or calcareous sedimentary rocks or rock debris occur at shallow depths.

**ERO** Rendzic Melanic Soils that have a peaty topsoil.

**Peaty Rendzic Melanic Soils**

**ERM** Rendzic Melanic Soils that have a mottled profile form

**Mottled Rendzic Melanic Soils**

**ERW** Other soils that have a weathered-B or cutanic horizon 10 cm or more thick.

**Weathered Rendzic Melanic Soils**

**ERT** Other soils.

**Typic Rendzic Melanic Soils**

**EM** MAFIC MELANIC SOILS

Mafic Melanic Soils occur in soil materials weathered from mafic and ultramafic rocks or tuffs (but not tuffaceous greywacke). They have relatively high proportions of dark-coloured magnesium- and iron-rich silicate minerals.

**EMG** Mafic Melanic Soils that have, in some part of the B or BC horizon, to

60 cm from the mineral soil surface, *either*

1. 5% (by volume) or more coarse rock fragments that consist mainly of ultramafic rocks, *or*
2. have an exchangeable calcium/magnesium molar ratio of 0.2 or less, and exchangeable magnesium of 1.5 cmolc/kg or more.

**Magnesic Mafic Melanic Soils**

**EMM** Other soils that have a mottled profile form.

**Mottled Mafic Melanic Soils**

**EML**

Other soils with either P retention of 85% or more, or a strong or very strong reactive-aluminium test, in some part of the B horizon, within 90 cm of the mineral soil surface.

**Allophanic Mafic Melanic Soils**

**EMA**

Other soils that have pH less than 5.5 in some part of the B horizon, within 60 cm of the mineral soil surface.

**Acidic Mafic Melanic Soils**

**EMT** Other soils.

**Typic Mafic Melanic Soils**

**EO** ORTHIC MELANIC SOILS

Orthic Melanic Soils occur in soil materials containing calcium carbonate or that have high calcium contents.

**EOMC** Orthic Melanic Soils that have both a calcareous horizon with an upper surface at 90 cm or less from the mineral soil surface, and a mottled profile form.

**Mottled-calcareous Orthic Melanic Soils**

**EOJC** Other soils that have an argillic horizon and a calcareous horizon with an upper surface at 90 cm or less from the mineral soil surface.

**Argillic-calcareous Orthic Melanic Soils**

**EODC** Other soils that have a moderately or strongly pedal weathered-B horizon 15 cm or more thick occurring immediately beneath the A horizon, and a calcareous horizon with an upper surface at 90 cm or less from the mineral soil surface.

**Pedal-calcareous Orthic Melanic Soils**

**EOC** Other soils that have a calcareous horizon with an upper surface at 90 cm or less from the mineral soil surface.

**Calcareous Orthic Melanic Soils**

**EOMJ** Other soils that have a mottled profile form, and an argillic horizon.

**Mottled-argillic Orthic Melanic Soils**

**EOM** Other soils that have a mottled profile form.

**Mottled Orthic Melanic Soils**

**EOJ** Other soils that have an argillic horizon.

**Argillic Orthic Melanic Soils**

**EOT** Other soils.

**Typic Orthic Melanic Soils**

# Organic Soils

### CONCEPT OF THE ORDER

Organic Soils are soils that occur in the partly decomposed remains of wetland plants (peat) or forest litter. Mineral soil material is commonly present but organic soil material is often dominant. The soils occur in sites where rates of organic-matter decomposition are balanced or exceeded by rates of plant biomass production and accumulation.

### CORRELATION

The order corresponds with the organic soils group of the NZ Genetic Soil Classification. It correlates with the Histosols of Soil Taxonomy.

### OCCURRENCE

Organic Soils occur in wetlands in most parts of New Zealand or under forest-produced acidic litter in areas with high precipitation.

### ACCESSORY PROPERTIES OF THE ORDER

1. *Low bulk density*. Due to the high organic matter content, bulk densities are very low, usually in the range of

0.03 to 0.4 Mg/m3.. Too few data are yet available to allow mineralogy classes to be stated.

1. *High cation exchange capacity*. The organic components of Organic Soils have high surface area, and high negative charge that varies markedly with pH. CEC values are very high, mostly ranging from 40 to 170 cmolc/kg.
2. *High carbon/nitrogen ratios*. C/N ratios range from 18 to as high as 70 in unfertilised and uncultivated Organic Soils.
3. *Low bearing strength*. Construction of buildings or roads requires special foundation design.
4. *Very low thermal conductivity*. Soils warm and cool slowly. Bare soil surfaces, however, have high radiance.
5. *High shrinkage potential*. The soils shrink markedly upon drying, and lose organic matter due to oxidation. Consequently, following drainage, the classification may change.
6. *High total available-water capacity*. While total available-water capacity is high, plant-available-water capacity may only be moderate, due to limits in rooting depth (anoxic conditions, species-specific limitations).
7. *Common nutrient deficiencies*. The major nutrients nitrogen, phosphorus, potassium and sulphur, and the trace elements copper, selenium and molybdenum, are frequently deficient for crops and pasture.
8. *Peats are very poorly drained, litters are variable*. Organic Soils formed in peats are very poorly drained and those formed from litters may range from well drained to very poorly drained.

### SUMMARY OF ORGANIC SOILS HIERARCHY

|  |  |  |  |
| --- | --- | --- | --- |
| Group | | Subgroup | Example of series |
| **OL**  Litter | | Buried-podzol | pt. Waitutu |
|  |  | Buried-gleyed | - |
|  |  | Orthic | pt. Waipoua |
| **OF** | Fibric | Sphagnic | Kaherekoau |
|  |  | Acid | pt. Rukuhia |
|  |  | Mellow | pt. Otanomomo |
| **OM** | Mesic | Acid | Otautau |
|  |  | Mellow | Kaipaki |
| **OH** | Humic | Acid | Ardmore |
|  |  | Mellow | Pukehina |

### KEY TO GROUPS OF ORGANIC SOILS

**OL** Organic Soils that occur entirely in partly or fully decomposed forest litter and are not almost continually saturated in the natural state (F and H horizons).

**LITTER ORGANIC SOILS**

**OF** Other soils that, from the upper surface of the organic soil material to 60 cm depth, or to the base of the organic soil material if shallower, have horizons dominated (by accumulated thickness) by fibric organic soil material (Of horizons).

**FIBRIC ORGANIC SOILS**

**OM** Other soils that, from the upper surface of the organic soil material to 60 cm depth, or to the base of the organic soil material if shallower, have horizons dominated (by accumulated thickness) by mesic organic soil material (Om horizons).

**MESIC ORGANIC SOILS**

**Oh** Other soils that, from the upper surface of the organic soil material to 60 cm depth, or to the base of the organic soil material if shallower, have horizons dominated (by accumulated thickness) by humified organic soil material (Oh horizons).

**HUMIC ORGANIC SOILS**

### KEY TO SUBGROUPS OF ORGANIC SOILS

**OL**  LITTER ORGANIC SOILS

Litter Organic Soils occur under forest beneath a canopy of acidic litter or mor-forming species. The organic material is derived predominantly from leaves and twigs and is normally not saturated except for a few days following heavy rain.

**OLBZ** Litter Organic Soils in which an underlying mineral soil, with an upper boundary at less than 90 cm from the soil surface, has a podzolic-B or placic horizon.

**Buried-podzol Litter Organic Soils**

**OLBG** Other soils in which a reductimorphic horizon occurs at less than 30 cm beneath the upper surface of the underlying mineral soil.

**Buried-gley Litter Organic Soils**

**OLO** Other soils.

**Orthic Litter Organic Soils**

**OF** FIBRIC ORGANIC SOILS

Fibric Organic Soils occur in sites that are saturated to the surface for extended periods (or in sites that have been artificially drained) in which the peat materials are only weakly decomposed. The wetland plant constituents are so little decomposed that their botanic origin may be readily determined and fibres are not destroyed by rubbing.

|  |  |
| --- | --- |
| **OFS** | Fibric Organic Soils in which the organic fibres, to a depth of 60 cm from the soil surface, or to the base of organic soil material if shallower, are more than 70% *Sphagnum* species.  **Sphagnic Fibric Organic Soils** |
| **OFA** | Other soils in which the organic soil material, to a depth of 60 cm from the soil surface, or to its base if shallower, has pH of 4.5 or less throughout the major part.  **Acid Fibric Organic Soils** |
| **OFM** Other soils. | |

**Mellow Fibric Organic Soils**

**OM** MESIC ORGANIC SOILS

Mesic Organic Soils occur in very wet sites (or in sites that have been artificially drained) in which the peat materials are moderately decomposed. The remains of up to two-thirds of the original wetland plants that make up the bulk of the soil are unrecognisable or are largely destroyed by rubbing between the fingers.

**OMA** Other soils in which the organic soil material, to a depth of 60 cm from the soil surface, or to its base if shallower, has pH of 4.5 or less throughout the major part.

**Acid Mesic Organic Soils**

**OMM** Other soils.

**Mellow Mesic Organic Soils**

**OH** HUMIC ORGANIC SOILS

Humic Organic Soils occur in very wet sites (or in sites that have been artificially drained). The peat materials are strongly decomposed to the extent that the original wetland plant remains cannot be recognised throughout most of the soil profile.

**OHA** Humic Organic Soils in which the organic soil material, to a depth of 60 cm from the soil surface, or to its base if shallower, has pH of 4.5 or less throughout the major part.

**Acid Humic Organic Soils**

**OHM** Other soils.

**Mellow Humic Organic Soils**

# Oxidic Soils

### CONCEPT OF THE ORDER

Oxidic Soils contain low-activity phyllosilicate clays and secondary oxides which give rise to variable charge properties. They form in the clayey weathering products of mafic rocks. The soils have a fine or very fine polyhedral fabric with friable failure to stable microaggregates of 2 mm or less, and low plasticity in relation to clay content. Surface horizons are clayey, and an increase in clay content occurs with depth although clay illuvial features are generally not apparent.

### CORRELATION

The order comprises most of the strongly weathered red loams and brown loams, many northern brown granular clays, and a few brown granular soils from ash beds and basaltic and andesitic rocks of the NZ Genetic Soil Classification. It correlates with the Oxisols of Soil Taxonomy.

### OCCURRENCE

Oxidic Soils are only known to occur in the Auckland and Northland regions.

### ACCESSORY PROPERTIES OF THE ORDER

1. *Low-activity clay*. CEC is low at field pH. ECEC is less than 12 cmolc/kg (clay), and CEC is less than 16 cmolc/kg (clay). The soils are weakly buffered. Some subhorizons have a net positive charge. Oxidic Soils usually have the following mineralogy classes: Kandic, Ferritic or Aluminitic.
2. *High phosphate retention*. P retention ranges from 60 to 90%. High sulphate adsorption occurs in B horizons.
3. *Parent materials*. The soils are derived from andesites, dolerites and basalts of mid-Pleistocene and older ages.
4. *Limited root depth*. The extension of plant roots is limited by high dry bulk density and high penetration resistance, particularly in well drained soils. Plant root depths are shallow to medium.
5. *Moderate or rapid infiltration*. Hydraulic conductivity of surface horizons and upper B horizons is moderate or faster, giving excellent trafficability and workability immediately after rain.
6. *Slow permeability*. Hydraulic conductivity decreases to slow or margin- ally slow values with depth, such that perching of water occurs within the root zone after high intensity rainfalls. The duration of wetness varies from 1 to 2 days in well drained soils to 4 days or more in poorly drained soils.
7. *Soil water deficit*. Deficits occur in summer and are exacerbated by low readily available water capacities and shallow rooting depths.
8. *High clay content*. Clay content ranges from 50 to 90%.
9. *Well-developed structure*. Topsoils have mostly well-developed spheroidal or polyhedral peds. Topsoil bulk densities are low.
10. *Strongly weathered with very low nutrient reserves*. The soils have very low reserves of potassium, magnesium, calcium and phosphorus.

### SUMMAY OF OXIDIC SOILS HIERARCHY

|  |  |  |
| --- | --- | --- |
| Group | Subgroup | Example of series |
| **XP**  Perch-gley | Nodular | Kapiro |
|  | Typic | Otaha |
| **XN**  Nodular | Typic | Okaihau |
| **XO**  Orthic | Mottled | Puketotara |
|  | Brown | Tanekaha |
| Typic Kerikeri | | |

### KEY TO GROUPS OF OXIDIC SOILS

**XP** Oxidic Soils that have *both*

1. a gley profile form, *and*
2. perch-gley features.

**PERCH-GLEY OXIDIC SOILS**

**XN** Other Oxidic Soils that have a nodular horizon with an upper boundary within 60 cm of the mineral soil surface.

**NODULAR OXIDIC SOILS**

**XO** Other Oxidic Soils.

**ORTHIC OXIDIC SOILS**

### KEY TO SUBGROUPS OF OXIDIC SOILS

**XP** PERCH-GLEY OXIDIC SOILS

Perch-gley Oxidic Soils occur in sites that are periodically saturated (unless artificially drained). Wetness and associated reducing conditions are indicated by grey colours, and are caused by perching on a slowly permeable layer.

**XPN** Perch-gley Oxidic Soils that have a nodular horizon with an upper boundary within 60 cm of the mineral soil surface.

**Nodular Perch-gley Oxidic Soils**

**XPT** Other soils.

**Typic Perch-gley Oxidic Soils**

**XN** NODULAR OXIDIC SOILS

Nodular Oxidic Soils occur in clayey soil materials derived from Pliocene or early Pleistocene basalts. They have clay-enriched B horizons and a prominent layer of iron oxide nodules. The soils have extremely low CEC (at natural pH) and natural fertility. Intermittent wetness is usual.

**XNT** Only one subgroup is recognised.

**Typic Nodular Oxidic Soils**

**XO** ORTHIC OXIDIC SOILS

Orthic Oxidic Soils occur in clayey soil materials derived from early to mid-Pleistocene basalts. They have clay-enriched B horizons but lack prominent nodules, although up to 2% may be present in some horizons.

**XOM** Orthic Oxidic Soils that have a mottled profile form.

**Mottled Orthic Oxidic Soils**

**XOB** Other soils that have within 90 cm of the mineral soil surface,

*either*

1. a decrease in clay content with depth of more than 20% relative to the horizon with maximum clay, *or*
2. more than 5% weathered coarse rock fragments within 90 cm of the mineral soil surface.

**Brown Orthic Oxidic Soils**

**XOT** Other soils.

**Typic Orthic Oxidic Soils**

# Pallic Soils

### CONCEPT OF THE ORDER

Pallic Soils are soils with moderate to high base status and low contents of secondary iron oxides. They have pale colours, high slaking potential and high density in subsurface horizons. Pallic Soils have water deficits in summer, and soil water surpluses in winter or spring.

### CORRELATION

The order comprises most yellow-grey earths, associated steepland soils, intergrades between yellow-grey earths and yellow-brown earths, and intergrades between yellow-grey earths and brown-grey earths of the NZ Genetic Soil Classification. Most Pallic Soils are correlated with Alfisols and Inceptisols in Soil Taxonomy, particularly those under ustic or udic moisture regimes, with aquic conditions, or ochric epipedons.

### OCCURRENCE

Pallic Soils occur predominantly in the seasonally dry eastern part of North and South Islands, and in the Manawatu.

### ACCESSORY PROPERTIES OF THE ORDER

1. *Low concentrations of secondary oxides*. P retention is less than 30% in topsoils and subsoils. Extractable iron and aluminium values are low or moderate, with a significant proportion of secondary iron oxides occurring in redox segregations.
2. *High base status*. Base saturation values in subsoils are high (more than 50%), except in perch-gleyed soils, where values may be lower in horizons overlying fragipans.
3. *Felsic parent materials*. Parent materials are predominantly loess or sediments derived from quartzo-feldspathic rocks (schist or greywacke).
4. *Mica/illite clay minerals*. Pallic Soils usually belong either to the Illitic or to a Clay-mineralic mineralogy class.
5. *Slow permeability*. Subsurface horizons have restricted permeability, particularly in soils with fragipans or duripans in which the permeability is very slow.
6. *Perched water-tables*. Soils that are poorly or moderately well drained have water-tables perched on slowly permeable layers.
7. *Limited root depth*. Potential rooting depth in most soils is limited by a subsurface horizon of high bulk density at shallow depths, or by brittle silty cappings on stones.
8. *Strongly worm-mixed*. Topsoils generally have a significant proportion of worm casts and a distinct worm-mixed horizon occurs in the transition from A to B horizons. Topsoil worm activity is greatly reduced during summer periods of soil moisture deficit.
9. *High slaking and dispersion potential*. Soil material, particularly in B horizons, is strongly dispersive and will readily slake. Topsoil structures may break down under prolonged impact by heavy machinery or by continuous tillage.
10. *Droughty summers, moist winters*. Precipitation ranges from about 500 to 1000 mm per year. A spring surplus of soil water is common but the annual surplus is less than about 200 mm. The average annual deficit is approximately 90–200 mm/year.
11. *Phosphorus status*. A high proportion of the inorganic phosphorus is non-occluded and a relatively high proportion of total phosphorus is in an organic form.
12. *Sulphur status*. Levels of extractable sulphate are low.

### SUMMARY OF PALLIC SOILS HIERARCHY

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Group | | Subgroup | Example of series | |
| **PP**  Perch-gley | | Duric | pt. Poporangi | |
|  | | Argillic-fragic | Tokomaru | |
|  | | Fragic | Otokia | |
|  | | Weathered-argillic | Nalder | |
|  | | Argillic | Marton | |
|  | | Cemented | Caroline | |
|  | | Typic | pt. Salix | |
| **PU** | Duric | Mottled | pt. Matapiro |
|  |  | Argillic-sodic | - |
|  |  | Argillic | pt. Matapiro |
|  |  | Typic | - |
| **PX** | Fragic | Argillic-sodic | Wither |
|  |  | Argillic-mottled | - |
|  |  | Argillic-calcareous | Grampians |
|  |  | Argillic | Seaview |
|  |  | Mottled-calcareous | pt. Cluden |
|  |  | Mottled | Timaru |
|  |  | Calcareous-sodic | pt. Grampians |
|  |  | Calcareous | pt. Takahe |
|  |  | Typic | Tima |
| **PL** | Laminar | Mottled | Pukeuri |
|  |  | Calcareous | - |
|  |  | Typic | Otama |
| **PJ** | Argillic | Mottled-weathered | Okuku |
|  |  | Mottled | Halcombe |
|  |  | Aged | Naseby |
|  |  | Mottled-ultic | - |
|  |  | Ultic | Rosedale |
|  |  | Sodic | - |
|  |  | Weathered | - |
|  |  | Calcareous | - |
|  |  | Typic | Abbotsford |
| **PI** | Immature | Mottled-pedal | - |
|  |  | Mottled | Wakanui |
|  |  | Calcareous | - |
|  |  | Pedal | Kiwi |
|  |  | Typic | Templeton |

### KEY TO GROUPS OF PALLIC SOILS

**PP** Pallic Soils that have both a gley profile form and perch-gley features.

**PERCH-GLEY PALLIC SOILS**

**PU** Other soils that have a duripan.

**DURIC PALLIC SOILS**

**PX** Other soils that have a fragipan.

**FRAGIC PALLIC SOILS**

**PL** Other soils that have a brittle-B horizon and an argillic horizon that is predominantly in the form of lamellae.

**LAMINAR PALLIC SOIL**

**PJ** Other soils that have an argillic horizon, or a cutanic horizon with sodic features within it or immediately beneath it.

**ARGILLIC PALLIC SOILS**

**PI** Other soils.

**IMMATURE PALLIC SOILS**

### KEY TO SUBGROUPS OF PALLIC SOILS

**PP** PERCH-GLEY PALLIC SOILS

Perch-gley Pallic soils occur in sites that are periodically saturated (if undrained) in winter and spring, but dry out in summer. The wetness and associated reducing conditions are indicated by grey colours on ped surfaces in horizons directly beneath the topsoil. Wetness is caused by perching of water on a slowly permeable subsurface layer, either a fragipan, argillic horizon, duripan, or other slowly permeable layer. The reductimorphic horizons are commonly acidic (pH less than 5.5).

**PPU** Perch-gley Pallic Soils that have a duripan.

**Duric Perch-gley Pallic Soils**

**PPJX** Other soils that have both an argillic horizon and a fragipan.

**Argillic-fragic Perch-gley Pallic Soils**

**PPX** Other soils that have a fragipan.

**Fragic Perch-gley Pallic Soils**

**PPWJ** Other soils in which the majority of the coarse rock fragments are weathered **enough to be** easily broken with hammer or spade, and that contain an argillic horizon.

**Weathered-argillic Perch-gley Pallic Soils**

**PPJ** Other soils that have an argillic horizon.

**Argillic Perch-gley Pallic Soils**

**PPC** Other soils that have a horizon that is cemented to the degree that it is at least weakly indurated, within 90 cm of the mineral soil surface.

**Cemented Perch-gley Pallic Soils**

**PPT** Other soils.

**Typic Perch-gley Pallic Soils**

**PU** DURIC PALLIC SOILS

Duric Pallic Soils occur in areas with pronounced soil moisture deficits and often have some proportion of tephra in the soil parent material, or high exchangeable sodium. The total silica contents are not high, but sufficient silica has been mobilised to form a pan that impedes roots and water.

**PUM** Duric Pallic Soils that have a mottled profile form.

**Mottled Duric Pallic Soils**

**PUJN** Other soils that have an argillic horizon, or a cutanic horizon that within or immediately beneath has sodic features.

**Argillic-sodic Duric Pallic Soils**

**PUJ** Other soils that have an argillic horizon.

**Argillic Duric Pallic Soils**

**PUT** Other soils.

**Typic Duric Pallic Soils**

**PX** FRAGIC PALLIC SOILS

Fragic Pallic Soils occur in soil materials that are predominantly silty. A fragipan which severely restricts the movement of water and penetration of roots occurs below the base of the B horizon.

**PXJN** Fragic Pallic Soils that have *both*

1. an argillic or cutanic horizon overlying the fragipan, and
2. sodic features within or immediately above the fragipan.

**Argillic-sodic Fragic Pallic Soils**

**PXMJ** Other soils that have *both*

1. an argillic horizon overlying the fragipan, and
2. a mottled profile form.

**Mottled-argillic Fragic Pallic Soils**

**PXJC** Other soils that have *both*

1. an argillic horizon, *and*
2. a calcareous horizon

**Argillic-calcareous Fragic Pallic Soils**

**PXJ** Other soils with an argillic horizon overlying the fragipan.

**Argillic Fragic Pallic Soils**

**PXMC** Other soils that have *both*

1. a mottled profile form, *and*
2. a calcareous horizon immediately beneath the fragipan, or calcareous material within prism interiors of the fragipan.

**Mottled-calcareous Fragic Pallic Soils**

**PXM** Other soils that have a mottled profile form.

**Mottled Fragic Pallic Soils**

**PXCN** Other soils that have *both*

1. a calcareous horizon immediately beneath the fragipan or calcareous material within prism interiors of the fragipan, *and*
2. sodic features within, or immediately beneath, the fragipan.

**Calcareous-sodic Fragic Pallic Soils**

|  |  |
| --- | --- |
| **PXC** | Other soils that have a calcareous horizon immediately beneath the fragipan, or calcareous material within prism interiors of the fragipan.  **Calcareous Fragic Pallic Soils** |
| **PXT** | Other soils. |

**Typic Fragic Pallic Soils**

**PL** LAMINAR PALLIC SOILS

Laminar Pallic Soils occur predominantly in fine sandy or silty loess or alluvium. Although rooting is impeded in the subsurface horizons it is not restricted to the degree that it is in a fragipan. The soils are generally slowly permeable.

**PLM**  Laminar Pallic Soils that have a mottled profile form.

**Mottled Laminar Pallic Soils**

**PLC** Other soils that have a calcareous horizon.

**Calcareous Laminar Pallic Soils**

**PLT** Other soils.

**Typic Laminar Pallic Soils**

**PJ** ARGILLIC PALLIC SOILS

Argillic Pallic Soils have no fragipan or duric horizon but have a clay-enriched B horizon in which clay coatings occur predominantly on polyhedral, blocky or prismatic ped surfaces, on surfaces of coarse rock fragments , or within tubular pores.

**PJMW** Soils that have *both*

1. a mottled profile form, *and*
2. coarse rock fragments, the majority of which are weathered to the extent that clasts can be easily broken by hammer or spade

**Mottled-weathered Argillic Pallic Soils**

**PJMU** Other soils that have *both*

|  |  |
| --- | --- |
|  | 1. an E horizon and pH less than 5.5 in some part of the argillic horizon, *and* |
|  | 2. a mottled soil profile form.  **Mottled-ultic Argillic Pallic Soils** |

|  |  |
| --- | --- |
| **PJM** | Other soils that have a mottled profile form.  **Mottled Argillic Pallic Soils** |
| **PJA** | Other soils that have hue 7.5YR or redder, or hue 10YR and chroma 6 or more, in some part of the argillic horizon. |

**Aged Argillic Pallic Soils**

|  |  |
| --- | --- |
| **PJU** | Other soils that have an E horizon and pH less than 5.5 in some part of the argillic horizon.  **Ultic Argillic Pallic Soils** |
| **PJN** | Other soils that have sodic features within or immediately beneath the argillic horizon.  **Sodic Argillic Pallic Soils** |
| **PJW** | Other soils that have coarse rock fragments, the majority of which are weathered to the extent that clasts can be easily broken by hammer or spade  **Weathered Argillic Pallic Soils** |

**PJC** Other soils that have a calcareous horizon with an upper surface occurring within 90 cm of the mineral soil surface, or occurring within or immediately below the argillic horizon.

**Calcareous Argillic Pallic Soils**

**PJT** Other soils.

**Typic Argillic Pallic Soils**

**PI** IMMATURE PALLIC SOILS

Immature Pallic Soils are insufficiently developed to have fragipans, duripans or argillic horizons. They have either a brittle-B horizon, eluvial features, a cutanic horizon, or slightly firm or stronger blocky, polyhedral or prismatic peds.

**PIMD** Immature Pallic Soils that have *both*

1. a mottled profile from, *and*
2. are moderately or strongly pedal, with peds 100 mm or less in horizontal diameter, throughout the major part of the B horizon to 60 cm from the mineral soil surface, or to the base of the B horizon if shallower.

**Mottled-pedal Immature Pallic Soils**

|  |  |
| --- | --- |
| **PIM** | Other soils that have a mottled profile form.  **Mottled Immature Pallic Soils** |
| **PIC** | Other soils that have a calcareous horizon with an upper surface within 90 cm of the mineral soil surface.  **Calcareous Immature Pallic Soils** |
| **PID** | Other soils that are moderately or strongly pedal, with peds 100 mm or less in horizontal diameter, throughout the major part of the B horizon to 60 cm from the mineral soil surface, or to the base of the B horizon if shallower.  **Pedal Immature Pallic Soils** |
| **PIT** | Other soils. |

**Typic Immature Pallic Soils**

# Podzols

### CONCEPT OF THE ORDER

Podzols are acidic soils with low base saturation. Podzols have a horizon of aluminium accumulation occurring as complexes with organic matter and/or as short-range-order minerals (typically with silicon as allophane/imogolite). Iron (typically as ferrihydrite) may or may not be accumulated with aluminium. This horizon is usually associated with an overlying E horizon, indicating translocation. The E horizon may be missing due to erosion, ploughing, or bioturbation, or it may be masked by organic matter.

### CORRELATION

Podzols correspond to the podzols and some podzolised yellow-brown earths of the NZ Genetic Soil Classification. They mostly correspond with the Spodosols of Soil Taxonomy.

### OCCURRENCE

Podzols occur in areas of high precipitation and are usually associated with forest species which produce an acidic litter. They are most common in Northland, the West Coast of the South Island, and at higher elevations.

### ACCESSORY PROPERTIES OF THE ORDER

1. *Secondary oxides strongly differentiated between horizons*. In A and E horizons, sand and silt grains are uncoated. In B horizons they are coated, and in some soils cemented, by short-range-order minerals and/or organic matter.
2. *Low base saturation*. Base saturations are very low, and the soils are extremely acidic, in A and E horizons. KCl-extractable-aluminium levels are high, and aluminium in soil solution may be toxic to some plants.
3. *Parent materials*. The soils occur mainly in materials from felsic rocks such as granite, greywacke, schist or rhyolite.
4. *Mineralogically differentiated*. Mica-smectite or smectite often occur in A and E horizons, and hydroxy-coated or interlayered minerals or allophane often occur in the B horizon. In some Northland soils, silica is dominant in B horizons. Podzols cover a wide range of mineralogy classes.
5. *Limited rooting depth*. The rooting depth is limited for many introduced plants by low pH, aluminium toxicity, or by pans which often cause problems of wetness.
6. *Low biological activity*. Low levels of faunal activity occur with a low rate of mineralisation. Carbon/nitrogen ratios are very high. The accumulation of weakly decomposed humus, and minimal incorporation of humus into the upper mineral soil, results in a mor-like humus form.
7. *Mor-forming vegetation*. The soils have been associated with vegetation producing an acidic litter of low nutrient content.
8. *Infertile*. The soils have very low natural fertility with high nitrogen, phosphorus, potassium and lime requirements.
9. *Wet climate*. The soils occur mainly in areas with a precipitation of 1400 mm or more and, unless sandy, are likely to have a soil water surplus for a considerable part of the year.

### SUMMARY OF PODZOLS HIERARCHY

|  |  |  |
| --- | --- | --- |
| Group | Subgroup | Example of series |
| **ZD**  Densipan Podzols | Humus-pan | pt. Te Kopuru |
|  | Ultic-humose | pt. Te Kopuru |
|  | Humose | - |
|  | Ortstein | - |
|  | Typic | Parahaki |
| **ZP**  Perch-gley Podzols | Fluid | Hukarere var. |
|  | Peaty-silt-mantled | pt. Okarito |
|  | Silt-mantled | pt. Okarito |
|  | Humus-pan | Addison |
|  | Humose-ortstein | Rutherglen |
|  | Humose-placic | Rakiura |
|  | Humose | Maimai |
|  | Ortstein | pt. Charleston |
|  | Placic | Maungatua |
|  | Typic | Rowallan |

|  |  |
| --- | --- |
| **ZG** Groundwater-gley Podzols Humose | - |
| Typic | - |
| **ZX** Pan Podzols Humus-pan | Kairua |
| Humose | Tautuku |
| Fragic | Nevis |
| Ortstein | Spencer |
| Placic | Pukepahi |
| Firm | - |
| **ZO** Orthic Podzols Humose | Borland |
| Typic | Shewell |

### KEY TO GROUPS OF PODZOLS

**ZD** Podzols that have a densipan (Ed horizon).

**DENSIPAN PODZOLS**

**ZP** Other Podzols that have *both*

1. an E horizon, with either the low chroma colours of a reductimorphic horizon, a peaty topsoil, or a placic horizon with redox-segregations in the E horizon, *and*
2. a slowly permeable layer or perch-gley features.

**PERCH-GLEY PODZOLS**

**ZG** Other Podzols that have *both*

1. either an E horizon with the low chroma colours of a reductimorphic horizon or a peaty topsoil, *and*
2. a BC or C horizon that has the greyish colours of a reductimorphic horizon, that *either*
   1. extends to more than 90 cm from the mineral soil surface, or
   2. has redox segregations that occur mainly as coatings on voids and/or skeletans.

**GROUNDWATER-GLEY PODZOLS**

**ZX** Other Podzols that have a subhorizon in the B horizon that is *both*

1. massive, *and*
2. has firm or greater moist soil strength or has moist or wet penetration resistance of 3100 kPa or more.

**PAN PODZOLS**

**ZO** Other Podzols.

**ORTHIC PODZOLS**

### KEY TO SUBGROUPS OF PODZOLS

**ZD** DENSIPAN PODZOLS

Densipan Podzols have a high density but uncemented pan within the E horizon at shallow depths which severely limits root penetration and water movement.

**ZDU** Densipan Podzols that have a humus-pan.

**Humus-pan Densipan Podzols**

**ZDYH** Other soils that have a Bh horizon more than 5 cm thick that occurs within the top of a clayey prismatic B horizon.

**Ultic-humose Densipan Podzols**

**ZDH** Other soils that have a Bh horizon 5 cm or more thick.

**Humose Densipan Podzols**

**ZDQ** Other soils that have an ortstein-pan.

**Ortstein Densipan Podzols**

**ZDT** Other soils.

**Typic Densipan Podzols**

**ZP** PERCH-GLEY PODZOLS

Perch-gley Podzols occur in periodically, or predominantly, saturated sites (unless artificially drained) in which wetness is indicated by grey colours along with brownish or reddish mottles or peaty topsoils. The wetness is caused by the perching of water on a slowly permeable subsurface layer, although a groundwater-table may also be present.

**ZPF** Perch-gley Podzols that have a moderately fluid or very fluid fluidity class in some part above the podzolic-B horizon.

**Fluid Perch-gley Podzols**

**ZPOZ** Other soils that have *both*

1. an E horizon that
   1. has slightly firm or greater moist soil strength, and
   2. is apedal massive, or has very coarse to extremely coarse prismatic structure, and
   3. occurs within a silty layer that has a thickness of at least 15 cm, *and*
2. a peaty topsoil.

**Peaty-silt-mantled Perch-gley Podzols**

|  |  |
| --- | --- |
| **ZPZ** | Other soils that have an E horizon that has slightly firm or greater moist soil strength, is apedal massive, or has very coarse to extremely coarse prismatic structure, and occurs within a layer that is silty and at least 15 cm thick.  **Silt-mantled Perch-gley Podzols** |
| **ZPU** | Other soils that have a humus-pan. |

**Humus-pan Perch-gley Podzols**

**ZPHQ** Other soils that have a Bh horizon thicker than 5 cm, and an ortstein-pan.

**Humose-ortstein Perch-gley Podzols**

**ZPHP** Other soils that have a Bh horizon thicker than 5 cm, and a placic horizon.

**Humose-placic Perch-gley Podzols**

**ZPH** Other soils that have a Bh horizon thicker than 5 cm.

**Humose Perch-gley Podzols**

**ZPQ** Other soils with an ortstein-pan.

**Ortstein Perch-gley Podzols**

**ZPP**  Other soils that have a placic horizon.

**Placic Perch-gley Podzols**

**ZPT** Other soils.

**Typic Perch-gley Podzols**

**ZG** GROUNDWATER-GLEY PODZOLS

Groundwater-gley Podzols occur in periodically or predominantly saturated sites (unless artificially drained) in which the wetness is indicated by brownish or reddish mottles or peaty topsoils. The wetness is caused by a groundwater-table.

**ZGH** Groundwater-gley Podzols that have a Bh horizon thicker than 5 cm.

**Humose Groundwater-gley Podzols**

**ZGT** Other soils.

**Typic Groundwater-gley Podzols**

**ZX** PAN PODZOLS

Pan Podzols have a firm or indurated layer which restricts the penetration of roots and reduces permeability.

|  |  |
| --- | --- |
| **ZXU** | Pan Podzols that have a humus-pan.  **Humus-pan Pan Podzols** |
| **ZXH** | Other soils that have a Bh horizon, and either an ortstein-pan or placic horizon.  **Humose Pan Podzols** |
| **ZXX** | Other soils that have a fragipan.  **Fragic Pan Podzols** |
| **ZXQ** | Other soils that have an ortstein-pan.  **Ortstein Pan Podzols** |
| **ZXP** | Other soils that have a placic horizon. |

**Placic Pan Podzols**

**ZXF** Other soils.

**Firm Pan Podzols**

**ZO** ORTHIC PODZOLS

Orthic Podzols are well, or moderately well,drained and do not have a pan or a firm horizon with massive structure.

**ZOH** Orthic Podzols with a Bh horizon thicker than 5 cm.

**Humose Orthic Podzols**

**ZOT** Other soils.

**Typic Orthic Podzols**

# Pumice Soils

### CONCEPT OF THE ORDER

Pumice Soils are soils that have properties dominated by pumiceous and glassy rock fragments, and low clay content (typically containing allophanic material). They occur in sandy or pumiceous tephra ranging from 700 to 3500 years in age.

### CORRELATION

Pumice Soils include the yellow-brown pumice soils of the NZ Genetic Soil Classification, and a few yellow-brown loams with high glass content and moderate P retention. They correlate mainly with the Vitrands Suborder, or the Great Groups of Vitricryands or Vitraquands of Soil Taxonomy.

### OCCURRENCE

Pumice Soils occur in sandy or pumiceous volcanic ashes which are relatively young. They are distributed in the central North Island, particularly in the Volcanic Plateau.

### ACCESSORY PROPERTIES OF THE ORDER

1. *Short-range-order clay minerals*. Clay contents are low, generally less than 10%. The clay minerals are dominantly allophane and imogolite and occur as coatings around glass or pumice particles. Phosphate retention is moderate or high. Most Pumice Soils belong to the Glassy or Amorphic mineralogy classes.
2. *Low soil strength*. Soil strength is weak or very weak. The soils are apedal earthy, single-grain or extremely fine spheroidal, except in welded layers which are massive and may have higher strength.
3. *Pumice is not strongly altered*. The alteration status of coarse pumice fragments ranges from fresh to moderately weathered. Glass is predominant in sand fractions.
4. *Deep rooting*. The soils provide a deep rooting medium, except in welded ignimbrite.
5. *Very high macroporosity*. The macroporosity enables rapid drainage at low soil-water tensions. The available water capacity is high.
6. *Sensitive*. The soils are non-plastic and are sensitive, with low strength when disturbed.
7. *Resistant to pugging*. Water contents at field capacity are less than the plastic limit. Pumice Soils may, however, be susceptible to compaction on loading, with consequent reduced infiltration.
8. *Low reserves of major nutrient elements*. Sulphur, potassium, nitrogen, phosphorus and magnesium are usually required for agricultural or horticultural crops. Reserve potassium is low and exchangeable magnesium is very low, particularly in subsoils.
9. *Trace elements are likely to be deficient*. Trace elements that are possibly deficient include cobalt, copper, molybdenum, boron, iodine and selenium.
10. *Erosive*. The potential for erosion by water is high.

### SUMMARY OF PUMICE SOILS HIERARCHY

|  |  |  |  |
| --- | --- | --- | --- |
| Group | | Subgroup | Example of series |
| **MP**  Perch-gley | | Duric | Mangawhero |
|  |  | Typic | - |
| **MI** | Impeded | Mottled-welded | pt Atiamuri |
|  |  | Welded | Atiamuri |
|  |  | Mottled | - |
|  |  | Typic | - |
| **MO** | Orthic | Mottled | - |
|  |  | Podzolic | Rangipo |
|  |  | Allophanic | Lowgarth |
|  |  | Buried-allophanic | Paengaroa |
|  |  | Immature | Taupo |
|  |  | Typic | Turangi |

### KEY TO GROUPS OF PUMICE SOILS

**MP** Pumice Soils that have *both*

1. a gley profile form, *and*

2. perch-gley features.

**PERCH-GLEY PUMICE SOILS**

**MI** Other Pumice Soils that have a slowly permeable layer, or a welded layer that has brittle failure and no roots, within 90 cm of the mineral soil surface.

**IMPEDED PUMICE SOILS**

**MO** Other Pumice Soils.

**ORTHIC PUMICE SOILS**

### KEY TO SUBGROUPS OF PUMICE SOILS

**MP** PERCH-GLEY PUMICE SOILS

Perch-gley Pumice Soils occur in periodically saturated sites (unless artificially drained) in which wetness is indicated by grey colours along with brownish or reddish mottles. The wetness is caused by perching of water on a slowly permeable subsurface layer, although a groundwater-table may also be present.

**MPU** Perch-gley Pumice Soils containing a duripan within 90 cm of the mineral soil surface.

**Duric Perch-gley Pumice Soils**

**MPT** Other soils.

**Typic Perch-gley Pumice Soils**

**MI** IMPEDED PUMICE SOILS

Impeded Pumice Soils have a horizon that severely restricts the movement of water and usually the penetration of roots. The restrictive horizon is commonly a layer of welded ignimbrite.

**MIMW**  Impeded Pumice Soils that have *both*

1. a welded layer of ignimbrite that has brittle failure and acts as a root barrier with an upper boundary within 90 cm of the mineral soil surface, *and*
2. a mottled profile form.

**Mottled-welded Impeded Pumice Soils**

**MIW** Other soils that have a welded layer of ignimbrite that has brittle failure and acts as a root barrier with an upper boundary within 90 cm of the mineral soil surface.

**Welded Impeded Pumice Soils**

**MIM** Others soils with a mottled profile form.

**Mottled Impeded Pumice Soils**

**MIT** Other soils.

**Typic Impeded Pumice Soils**

**MO**  ORTHIC PUMICE SOILS

Orthic Pumice Soils are well drained to imperfectly drained, are deep rooting and do not severely restrict water movement.

**MOM** Orthic Pumice Soils that have a mottled profile form.

**Mottled Orthic Pumice Soils**

**MOZ** Other soils that have a B horizon, or subhorizon of the B, that is thicker than 20 cm and has hue 7.5YR or more.

**Podzolic Orthic Pumice Soils**

**MOL** Other soils that have a layer within the thickness of vitric soil material, that meets the requirements of an allophanic soil material (except for bulk density).

**Allophanic Orthic Pumice Soils**

**MOBL** Other soils with a layer of vitric soil material within the B or BC horizon and with a base at less than 60 cm from the mineral soil surface , that overlies a layer which fails to meet the requirements of a vitric soil material but meets the requirements of allophanic soil material (except bulk density).

**Buried-allophanic Orthic Pumice Soils**

**MOI** Other soils with a Bw that is 30 cm or less thick and has hue 10YR or yellower and chroma 4 or less.

**Immature Orthic Pumice Soils**

**MOT** Other soils.

**Typic Orthic Pumice Soils**

# Raw Soils

### CONCEPT OF THE ORDER

Raw Soils 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. They include beach sands, alpine rock areas and active screes, lagoons and tidal estuaries.

### CORRELATION

Raw Soils correspond in part with very weakly developed recent soils of the NZ Genetic Soil Classification, and in part with materials that were often not considered to be soil. They are either Entisols or are unclassified in Soil Taxonomy.

### OCCURRENCE

Raw Soils occur scattered throughout New Zealand, particularly in association with high mountains, braided rivers, beaches and tidal mudflats.

### ACCESSORY PROPERTIES OF THE ORDER

1. *No B horizons*. Pedogenetic horizons are lacking apart from a rudimentary topsoil.
2. *Fresh or weakly weathered*. Coarse fragments and sand particles are generally without coatings, although rock fragments in some screes may have weathering rinds.
3. *Inherited mineralogy*. The soil mineralogy is very similar to that of the parent material and a range of mineralogy classes is possible.
4. *In soils with a fluid subsurface layer, a continuously high water-table is present*. The deposition of fresh sediment may occur.
5. *Non-fluid soils occur in environments with active erosion or deposition*.
6. *Low fertility*. Nitrogen, in particular, is deficient.
7. *Erosive*. Most materials are unaggregated and likely to be highly erosive.
8. *Sparse vegetation*. Vegetation is either absent, sparse or patchy, often consisting of ephemeral herbaceous plants, mosses or lichens. Mangroves occur mainly on Raw Soils.

### SUMMARY OF RAW SOILS HIERARCHY

|  |  |  |  |
| --- | --- | --- | --- |
| Group | | Subgroup | Example of series |
| **WG** | Gley Raw Soils | Fluid­sulphidic | pt. Takahiwai |
|  |  | Sulphidic | ­ |
|  |  | Fluid­saline | ­ |
|  |  | Saline | pt. Takahiwai |
|  |  | Fluid | pt. Paratai |
|  |  | Sandy | ­ |
|  |  | Typic | ­ |
| **WH** | Hydrothermal Raw Soils | Active | ­ |
| **WW** | Hydric Raw Soils |  |  |
| **WX** | Rocky Raw Soils | ­ | pt. Alpine |
| **WS** | Sandy Raw Soils | ­ | pt. Riverton |
| **WF** | Fluvial Raw Soils | ­ | pt. Selwyn |
| **WT** | Tephric Raw Soils | ­ | pt. Ngauruhoe |
| **WO** | Orthic Raw Soils | ­ | pt. Alpine |

### KEY TO GROUP OF RAW SOILS

**WG** Raw Soils that at 30 cm or less from the mineral soil surface have *either*

1. the upper boundary of a reductimorphic horizon, *or*
2. sufficient active ferrous iron to give a positive reaction to a,a'-dipyridyl at some time in the year, *or*
3. are saturated for 30 or more consecutive days in most years.

**GLEY RAW SOILS**

**WH** Other Raw Soils that have mean annual soil temperature at 30 cm depth of at least 2.5°C more than the mean annual air temperature.

**HYDROTHERMAL RAW SOILS**

**WX** Other Raw Soils with a lithic or paralithic contact within 30 cm of the soil surface.

**ROCKY RAW SOILS**

**WS** Other Raw Soils that have sand or loamy sand texture and that have less than 35% coarse rock fragments (by volume) in all horizons, from the soil surface to 60 cm depth or more.

**SANDY RAW SOILS**

**WF** Other Raw Soils that have fluvial features and are not buried by more than 30 cm of non­fluvial soil material.

**FLUVIAL RAW SOILS**

**WT** Other Raw Soils in tephric soil material from the soil surface to 30 cm depth or more.

**TEPHRIC RAW SOILS**

**WO** Other Raw Soils.

**ORTHIC RAW SOILS**

### KEY TO SUBGROUPS OF RAW SOILS

**WG** GLEY RAW SOILS

Gley Raw Soils occur in sites that are periodically or permanently flooded. Wetness is expressed in the soil by grey colours with brownish or reddish mottles, by water saturation or is indicated by a chemical test for the presence of reduced iron.

**WGFU** Soils that have *both*

1. moderately fluid or very fluid fluidity class at a depth of 30 cm or less, *and*
2. pH more than 4.0, and pH in boiling hydrogen peroxide less than 3.0, within 90 cm ofthe mineral soil surface.

**Fluid-sulphidic Gley Raw Soils**

**WGU** Other soils that have pH more than 4.0 and pH in boiling hydrogen peroxide less than 3.0, within 90 cm of the mineral soil surface.

**Sulphidic Gley Raw Soils**

**WGFQ** Other soils that, within 30 cm of the mineral soil surface, have *both*

1. moderately fluid or very fluid fluidity class, *and*
2. saline soil materials.

**Fluid-saline Gley Raw Soils**

|  |  |
| --- | --- |
| **WGQ** | Other soils that within 30 cm of the mineral soil surface have saline soil materials.  **Saline Gley Raw Soils** |
| **WGF** | Other soils that within 30 cm of the mineral soil surface have moderately fluid or very fluid fluidity class.  **Fluid Gley Raw Soils** |
| **WGS** | Other soils that have sand or loamy sand texture,and that have less than 35% coarse rock fragments (by volume) in all horizons, from the soil surface to 60 cm depth or more.  **Sandy Gley Raw Soils** |
| **WGT** | Other soils.  **Typic Gley Raw Soils** |

**t**

**WH** HYDROTHERMAL RAW SOILS

Hydrothermal Raw Soils occur in active hydrothermal areas affected by hot liquids or steam.

No subgroups have been defined.

**WX** ROCKY RAW SOILS

Rocky Raw Soils occur on rock outcrops subject to erosion. The soil volume available to roots is severely restricted. No subgroups have been defined.

**WW** HYDRIC RAW SOILS

Hydric Raw Soils have surface water present for a majority of the time. They are commonly part of an active riverbed or other shore environments (coastal, lakes).No subgroups have been defined.

**WS** SANDY RAW SOILS

Sandy Raw Soils occur in areas of active sand erosion, transportation and deposition, most commonly as dune sands.

**WST** Soils in tephric soil material from the soil surface to 30 cm depth or more.

**Tephric Sandy Raw Soils**

**WSS** Other soils.

**Typic Sandy Raw Soils**

**WF** FLUVIAL RAW SOILS

Fluvial Raw Soils occur in sediments deposited by flowing water. They occur on land surfaces on which there is a high risk of flooding.

No subgroups have been defined.

**WT** TEPHRIC RAW SOILS

Tephric Raw Soils occur in unconsolidated sediments of volcanic origin including ash, cinders, lapilli, pumice and other pyroclastic material.

No subgroups have been defined.

**WO** ORTHIC RAW SOILS

Orthic Raw Soils occur in land that is being eroded, on rock outcrops or land that has received sediment emplaced primarily by slope processes.

No subgroups have been defined.

# Recent Soils

### CONCEPT OF THE ORDER

Recent Soils show only incipient marks of soil-forming processes because of youthfulness, truncation of an older solum or, less commonly, because the soil material is resistant to alteration. Soil formation has been sufficient to develop a distinct topsoil or, as in the case of fine-textured wetland soils, to have moderately fluid or very fluid layers not close to the surface, indicating the onset of pedogenesis. A continuous cover of vascular plants is normally well established. The concept of the order relates predominantly to weak soil development rather than to the length of time of soil formation.

### CORRELATION

The order correlates with the recent soils, but not the gleyed-recent soils, of the NZ Genetic Soil Classification. It correlates mainly with Entisols but overlaps with some Inceptisols and Andisols of Soil Taxonomy.

### OCCURRENCE

Recent Soils occur throughout New Zealand in young landscapes, including alluvial floodplains, steep, unstable slopes, and slopes mantled by young volcanic ash.

### ACCESSORY PROPERTIES OF THE ORDER

1. *Weak soil development*. Soil development is mostly confined to topsoils, with B horizon colours and/or pedality occurring in some soils.
2. *Base saturations are generally high*. Base saturations are usually high except in very humid areas.
3. Coarse rock fragments *or rock are not strongly altered*. The alteration status usually ranges from fresh to moderately weathered.
4. *Illitic mineralogy*. The soil mineralogy reflects the mineralogy of the parent material. Most Recent Soils have an Illitic mineralogy class, except for those formed in tephra which are usually Glassy.
5. *Deep rooting*. Although textures vary, potential rooting depths are mostly large. Subsurface horizons are usually apedal, or weakly pedal, and penetration may be limited in some soils.
6. *Good drainage*. Poorly drained or very poorly drained soils are not included.
7. *Low P retention*. P retentions are likely to be either low or very low unless the soils occur in mafic materials.
8. *High fertility*. Natural fertility is generally high.
9. *Subject to erosion or sedimentation*. The soils are susceptible to erosion and/or sedimentation.

### SUMMARY OF RECENT SOILS HIERARCHY

|  |  |  |  |
| --- | --- | --- | --- |
| Group | | Subgroup | Example of series |
| **RH** | Hydrothermal | - | - |
| **RX** | Rocky | Peaty-acidic | pt. Titiraurangi |
|  |  | Acidic | - |
|  |  | Typic | pt. Cadzow |
| **RS** | Sandy | Mottled | Waiowhiro |
|  |  | Acidic | Poison Bay |
|  |  | Tephric | Hangatahua |
|  |  | Typic | pt. Selwyn |
| **RF** | Fluvial | Mottled-acidic | Waiwhetu |
|  |  | Mottled-saline | pt. Motukarara |
|  |  | Saline | - |
|  |  | Mottled-weathered | Eweburn |
|  |  | Mottled | Hari Hari |
|  |  | Acidic-weathered | pt. Manawatu |
|  |  | Weathered | Waimakariri |
|  |  | Acidic | pt. Seaforth |
|  |  | Typic | pt. Selwyn |
| **RT** | Tephric | Mottled | - |
|  |  | Buried-pumice | Matahina |
|  |  | Buried-allophanic | - |
|  |  | Typic | Ngauruhoe |
| **RO** | Orthic | Mottled-pallic | - |
|  |  | Mottled | - |
|  |  | Acidic-weathered | - |
|  |  | Weathered | - |
|  |  | Acidic | - |
|  |  | Typic | Barhill |

### KEY TO GROUPS OF RECENT SOILS

**RH** Recent soils that have *either*

1. mean annual soil temperature at 30 cm from the mineral soil surface of at least 2.5°C more than the mean annual air temperature, *or*
2. pH of 4.8 or less in some part of a subsurface horizon at less than 60 cm from the mineral soil surface.

**HYDROTHERMAL RECENT SOILS**

**RX** Other Recent Soils that have a lithic or paralithic contact either directly beneath the A horizon or have a weathered-B, or unconsolidated C horizon, that is less than 10 cm thick.

**ROCKY RECENT SOILS**

**RS** Other Recent Soils that have sand or loamy sand texture and have less than 35% (by volume) coarse rock fragments, in all horizons between the base of the A horizon and 60 cm from the mineral soil surface. Lamellae of sandy loam (of insufficient thickness to meet the requirements of an argillic horizon) may be present.

**SANDY RECENT SOILS**

**RF** Other Recent Soils that have fluvial features and are not buried by more than 30 cm of non-fluvial soil material.

**FLUVIAL RECENT SOILS**

**RT** Other Recent Soils containing tephric soil material from the mineral soil surface to 30 cm depth or more.

**TEPHRIC RECENT SOILS**

**RO** Other Recent Soils

**ORTHIC RECENT SOILS**

### KEY TO SUBGROUPS OF RECENT SOILS

**RH** HYDROTHERMAL RECENT SOILS

Hydrothermal Recent Soils occur adjacent to active hydrothermal areas or areas that were formerly active. The soils indicate active or former hydrothermal activity by either elevated soil temperatures or extreme acidity, respectively. No subgroups have been defined

**RX** ROCKY RECENT SOILS

Rocky Recent Soils have rock at shallow depths, severely restricting the soil volume available to roots.

**RXOA** Rocky Recent Soils that have a peaty topsoil and a pH less than 5.5 in some part below 20 cm from the mineral soil surface.

**Peaty-acidic Rocky Recent Soils**

**RXMA** Other soils that have a mottled profile form and a pH less than 5.5 in some part below 20 cm from the mineral soil surface.

**Mottled-Acidic Rocky Recent Soils**

**RXM**  Other soils that have a mottled profile form.

**Mottled Rocky Recent Soils**

**RXA** Other soils that have pH less than 5.5 in some part below 20 cm from the mineral soil surface.

**Acidic Rocky Recent Soils**

**RXT** Other soils.

**Typic Rocky Recent Soils**

**RS**  SANDY RECENT SOILS

Sandy Recent Soils occur in sand deposits which are dominantly aeolian, and sometimes alluvial, in origin. Subsurface horizons are sandy.

**RSM** Sandy Recent Soils that have a mottled profile form.

**Mottled Sandy Recent Soils**

**RSA** Other soils that have pH less than 5.5 in some part between 20 and 60 cm from the mineral soil surface.

**Acidic Sandy Recent Soils**

**RSK** Other soils containing tephric soil material from the mineral soil surface to 30 cm depth or more

**Tephric Sandy Recent Soils**

**RST** Other soils.

**Typic Sandy Recent Soils**

**RF** FLUVIAL RECENT SOILS

Fluvial Recent Soils occur in sediments deposited by flowing water. Many occur on land surfaces that are susceptible to flooding.

**RFMA** Fluvial Recent Soils that have *both*

1. a mottled profile form, *and*
2. pH less than 5.5 in some part between the base of the A horizon and within 60 cm of the mineral soil surface.

**Mottled-acidic Fluvial Recent Soils**

**RFMQ** Other soils that have *both*

1. a mottled profile form, *and*
2. have saline soil materials within 60 cm of the mineral soil surface at some time of the year.

**Mottled-saline fluvial Recent Soils**

**RFQ** Other soils that have saline soil materials within 60 cm of the mineral soil surface at some time of the year.

**Saline Fluvial Recent Soils**

**RFMW** Other soils that have *both*

1. a mottled profile form, *and*
2. a weathered-B horizon with its lower boundary at 30 cm or more from the mineral soil surface.

**Mottled-weathered Fluvial Recent Soils**

**RFM** Other soils that have a mottled profile form.

**Mottled Fluvial Recent Soils**

|  |  |
| --- | --- |
| **RFAW** Other soils that have *both* | |
|  | 1. a weathered-B horizon with its lower boundary at 30 cm or more from the mineral soil surface, *and* 2. pH less than 5.5 in some part of the subsurface horizons within 60 cm of the mineral soil surface.   **Acidic-weathered Fluvial Recent Soils** |
| **RFW** | Other soils that have a weathered-B horizon with its lower boundary at 30 cm or more from the mineral soil surface.  **Weathered Fluvial Recent Soils** |
| **RFA** | Other soils that have pH less than 5.5 in some part of subsurface horizons within 60 cm of the mineral soil surface.  **Acidic Fluvial Recent Soils** |
| **RFT** | Other soils. |

**Typic Fluvial Recent Soils**

**RT** TEPHRIC RECENT SOILS

Tephric Recent Soils occur in unconsolidated sediments of volcanic origin.

|  |  |
| --- | --- |
| **RTM** | Tephric Recent Soils that have a mottled profile form.  **Mottled Tephric Recent Soils** |
| **RTBP** | Other soils that have a buried soil, where theupper surface of the buried soil occurs within 60 cm or less from the mineral soil surface and has a B or BC horizon that meets the requirements of vitric soil material.  **Buried-pumice Tephric Recent Soils** |
| **RTBL** | Other soils that have a buried soil, where the upper surface of the buried soil occurs within 60 cm or less from the mineral soil surface and has a B or BC horizon that meets the requirements of allophanic soil material, but not necessarily the requirements for bulk density.  **Buried-allophanic Tephric Recent Soils** |
| **RTT** | Other soils.  **Typic Tephric Recent Soils** |

**RO** ORTHIC RECENT SOILS

Orthic Recent Soils occur on land that is being eroded, or has received sediment that has been deposited mainly as a result of slope processes.

**ROMP**  Other soils that have *both*

1. a mottled profile form, *and*
2. meets part 2(b) of the requirements for Pallic Soils.

**Mottled-pallic Orthic Recent Soils**

**ROM** Orthic Recent Soils that have a mottled profile form.

**Mottled Orthic Recent Soils**

**ROAW** Other soils that have *both*

1. a weathered-B horizon with its lower boundary at 30 cm or more from the mineral soil surface, *and*
2. pH less than 5.5 in some part between the base of the A horizon and within 60 cm of the mineral soil surface.

**Acidic-weathered Orthic Recent Soils**

**ROW** Other soils that have a weathered-B horizon with its lower boundary at 30 cm or more from the mineral soil surface.

**Weathered Orthic Recent Soils**

**ROA** Other soils that have pH less than 5.5 in some part between the base of the A horizon and within 60 cm of the mineral soil surface.

**Acidic Orthic Recent Soils**

**ROT** Other soils.

**Typic Orthic Recent Soils**

# Semiarid Soils

### CONCEPT OF THE ORDER

Semiarid Soils are high base status soils in which a soil water deficit prevails over most of the growing season. Wetting fronts under natural climate conditions (i.e., in the absence of irrigation) fail to penetrate deeper than the base of the solum, with consequent accumulation of pedogenic carbonate and other soluble salts.

### CORRELATION

The order comprises brown-grey earths, associated steepland soils and intergrades between brown-grey earths and yellow-grey earths and recent soils of the NZ Genetic Soil Classification. In Soil Taxonomy, the order corresponds with the Aridisols but also with suborders under a xeric moisture regime (Xerepts, Xerults, Xeralfs, Xerorthents).

### OCCURRENCE

Semiarid Soils occur in the inland basins of Otago and southern Canterbury, where precipitation is less than about 500 mm per year.

### ACCESSORY FEATURES OF THE ORDER

1. *Low secondary oxides*. Secondary iron and aluminium oxide levels are very low. P retention levels are also very low (usually less than 15%).
2. *High base status*. Base saturation values in subsoils are high and rise to 100% at the base of the solum.
3. *Parent materials*. The soils occur in materials from non-calcareous quartzo-feldspathic schist and indurated sandstone (greywacke).
4. *Illitic clay mineralogy*. Mica/illite clay minerals predominate with trace primary chlorite and kaolinite. Semiarid Soils almost always have an Illitic mineralogy class unless they have a clay content of less than 10% and fall into the Mixed class.
5. *Permeability*. Saturated hydraulic conductivity is slow in soils with argillic or cutanic horizons, and in some other silty or fine sandy soils. Infiltration may be reduced by machine traffic or stock treading when soils are saturated by irrigation water.
6. *Drainage*. No poorly or very poorly drained soils are included.
7. *Available water capacity*. Available water capacity is limited in most subsoils.
8. *Low biological activity*. In the natural state, biological activity is limited by droughtiness.
9. *High slaking and dispersion potential*. Soil materials are strongly dispersive and will readily slake.
10. *Erosive*. The soils are susceptible to wind and water erosion.
11. *Weakly buffered*. The soils are weakly buffered because of low CEC and anion adsorption capacity. They are consequently very sensitive to management, showing rapid changes in response to fertilisation, irrigation and cultivation.
12. *Soluble salts*. Soluble salts are present in many soils and land management must consider the risk of salinisation.
13. *High sodium*. Sodium occupies a large proportion of the cation exchange complex, particularly in Semiarid Soils with argillic horizons, ..
14. *Climate*. Precipitation ranges from about 350 to 500 mm per year, with zero water surplus and a spring soil moisture deficit.

### SUMMARY OF SEMIARID SOILS HIERARCHY

|  |  |  |
| --- | --- | --- |
| Group | Subgroup | Example of series |
| **SA**  Aged-argillic | Mottled | - |
|  | Weathered | Clyde |
|  | Alkaline | pt. Drybread |
|  | Thick | Clyde |
|  | Typic | Lowburn |
| **SZ**  Solonetzic | Saline | pt. Chapman |
|  | Typic | Manorburn |

|  |  |  |  |
| --- | --- | --- | --- |
| **SJ** | Argillic | Mottled | pt. Waenga |
|  |  | Saline | pt. Ranfurly |
|  |  | Alkaline | Blackmans |
|  |  | Laminar | Manuherikia |
|  |  | Typic | pt. Ranfurly |
| **SI** | Immature | Mottled | pt. Linnburn |
|  |  | Saline | pt. Frazer |
|  |  | Alkaline | pt. Linnburn |
|  |  | Typic | - |

### KEY TO SUBGROUPS OF SEMIARID SOILS

**SA** Semiarid Soils that have an argillic horizon in which the matrix has, in part, 7.5YR or redder hues or 10YR hue with chroma 6 or more

**AGED-ARGILLIC SEMIARID SOILS**

**SZ** Other Semiarid Soils containing an argillic horizon that has prismatic or blocky peds with more than 10% coatings of colour value 4 or less, and pH of 8.6 or more in some part.

**SOLONETZIC SEMIARID SOILS**

**SJ** Other Semiarid Soils containing an argillic horizon, or a cutanic horizon that meets the requirements of a slowly permeable layer.

**ARGILLIC SEMIARID SOILS**

**SI** Other Semiarid Soils.

**IMMATURE SEMIARID SOILS**

### KEY TO SUBGROUPS OF SEMIARID SOILS

**SA** AGED-ARGILLIC SEMIARID SOILS

Aged-Argillic Semiarid Soils occur mainly on fans, terraces, or hill slopes that have been relatively stable since the mid to early Pleistocene. The argillic horizons are redder in colour than those in younger soils, and are usually slowly permeable.

**SAM** Aged-Argillic Semiarid Soils that have a mottled soil profile form.

**Mottled Aged-argillic Semiarid Soils**

**SAW** Other soils in which the majority of the coarse rock fragments are weathered to the extent that clasts can be easily broken by hammer or spade.

**Weathered Aged-argillic Semiarid Soils**

**SAK** Other soils that have pH of 8.6 or more in some part within 60 cm of the mineral soil surface.

**Alkaline Aged-argillic Semiarid Soils**

**SAH** Other soils with an argillic horizon 30 cm or more thick.

**Thick Aged-argillic Semiarid Soils**

**SAT** Other soils.

**Typic Aged-argillic Semiarid Soils**

**SZ** SOLONETZIC SEMIARID SOILS

Solonetzic Semiarid Soils have a higher proportion of exchangeable sodium than other Semiarid Soils. This tends to promote the dispersion of clay and organic matter, resulting in very slow permeability through the clay enriched B horizons.

**SZQ** Solonetzic Semiarid Soils that have saline soil materials within 60 cm of the mineral soil surface at some time of the year.

**Saline Solonetzic Semiarid Soils**

**SZT** Other soils.

**Typic Solonetzic Semiarid Soils**

**SJ** ARGILLIC SEMIARID SOILS

Argillic Semiarid Soils occur on land surfaces of early Holocene or late Pleistocene age. The argillic horizon is brown, dark brown or olive brown in colour and usually slowly permeable.

**SJM** Argillic Semiarid Soils that have a mottled profile form.

**Mottled Argillic Semiarid Soils**

|  |  |
| --- | --- |
| **SJQ** | Other soils that have saline soil materials within 60 cm of the mineral soil surface at some time of the year.  **Saline Argillic Semiarid Soils** |
| **SJK** | Other soils that have pH of 8.6 or more in some part within 60 cm of the mineral soil surface.  **Alkaline Argillic Semiarid Soils** |
| **SJL** | Other soils that have an argillic horizon that is predominantly in the form of lamellae.  **Laminar Argillic Semiarid Soils** |
| **SJT** | Other soils. |

**Typic Argillic Semiarid Soils**

**SI** IMMATURE SEMIARID SOILS

Immature Semiarid Soils occur on Holocene land surfaces. They do not have argillic horizons, but usually have accumulations of calcium carbonate.

|  |  |
| --- | --- |
| **SIM** | Immature Semiarid Soils that have a mottled profile form.  **Mottled Immature Semiarid Soils** |
| **SIQ** | Soils that have saline soil materials within 60 cm of the mineral soil surface at some time of the year.  **Saline Immature Semiarid Soils** |
| **SIK** | Other soils that have pH of 8.6 or more in some part within 60 cm of the mineral soil surface.  **Alkaline Immature Semiarid Soils** |
| **SIT** | Other soils. |

**Typic Immature Semiarid Soils**

# Ultic Soils

### CONCEPT OF THE ORDER

Ultic soils are acidic soils with clayey and/or organic illuvial features in subsoil horizons. They are developed in clayey weathering products of felsic sediments or igneous rocks and usually contain mixtures of clay minerals including kaolinite, halloysite, aluminium-interlayered vermiculite and smectite. A few are developed in the weathering products of limestones and greensands. They have low potassium, magnesium and phosphorus reserves and contain mostly highly weathered minerals. E horizons or other features such as skeletans in the upper parts of the Bt horizon are indicative of clay destruction/removal processes. Argillic horizons are usually present.

### CORRELATION

The order comprises most northern yellow-brown earths, podzolised northern yellow-brown earths, many central yellow-brown earths (particularly those described as derived from pre-weathered parent materials) and some northern podzols and yellow-brown sands of the NZ Genetic Soil Classification. Most Ultic Soils are Ultisols in Soil Taxonomy.

### OCCURRENCE

Ultic Soils are most common in the northern North Island, and the Wellington, Marlborough and Nelson regions.

### ACCESSORY PROPERTIES OF THE ORDER

1. *Acidity*. KCl-extractable aluminium levels of more than 1 cmolc/kg are usual in B horizons, and indicate toxic aluminium which may inhibit root function and may contribute to shallow rooting habits in aluminium-sensitive plants.
2. *Clayey subsoils*. CEC values are medium to high. Ultic Soils cover a wide range of mineralogy classes, Kandic and Smectitic being the most common.
3. *Low magnesium and potassium*. Low concentrations of reserve magnesium and potassium resulting from strong weathering.
4. *Strongly weathered with low nutrient reserves*. Low levels of 0.5**M** H2SO4- extractable phosphorus (usually less than 3 mg/100 g) and total phosphorus (usually less than 20 mg/100 g) are characteristic. The former reflects low solubility and/or a low level of inorganic phosphorus reserves. Phosphorus supply from inorganic sources under zero phosphorus input grassland farming is negligible after about 2 years. Strong weathering is indicated by low ratio of 0.5**M** H2SO4-extractable phosphorus to inorganic phosphorus, usually 0.25 or less.
5. *Slow permeability*. A slowly permeable layer occurs in clayey profiles. The majority of soils are imperfectly to poorly drained, few are well-drained. Soil water movement is mainly along planar voids.
6. *Susceptibility to livestock treading damage*. Clayey or low strength, silty surface horizons are susceptible to treading damage or compaction during wet periods.
7. *Dispersible surface horizons*. Surface horizons, especially silty ones, are dispersible according to the test of McQueen (1981), and are prone to erosion where the surface cover has been removed. Although P retention is usually moderate or high in B horizons, it may be low in A and E horizons consistent with low contents of secondary iron oxides.

### SUMMARY OF ULTIC SOILS HIERARCHY

|  |  |  |  |
| --- | --- | --- | --- |
| Group | | Subgroup | Example of series |
| **UD** | Densipan | Perch-gleyed | Wharekohe |
|  |  | Mottled | Hukerenui |
| **UE** | Albic | Perch-gleyed | Waikare, Okaka |
|  |  | Mottled | Rangiora |
|  |  | Yellow | Riponui |
| **UP** | Perch-gley | Sandy | pt. Tangitiki |
|  |  | Typic | Omu |
| **US** | Sandy | Albic | Tangitiki |
|  |  | Mottled | pt. Tangitiki |
|  |  | Typic | pt. Red Hill |

|  |  |  |  |
| --- | --- | --- | --- |
| **UY** | Yellow | Magnesic | - |
|  |  | Mottled-podzolic | Tennyson |
|  |  | Mottled | Puhoi |
|  |  | Podzolic | Opouri |
|  |  | Buried-granular | Kainui |
|  |  | Typic | Warkworth |

### KEY TO GROUPS OF ULTIC SOILS

**UD**  Ultic Soils that have a densipan (Ed horizon)

**DENSIPAN ULTIC SOILS**

**UE** Other Ultic Soils that have an Eg or Er horizon overlying a firm, clayey B horizon that has prismatic peds with humus and/or clay coatings in some part.

**ALBIC ULTIC SOILS**

**UP** Other Ultic Soils that have a gley profile form.

**PERCH-GLEY ULTIC SOILS**

**US** Other Ultic soils with more than 60% sand in the B horizon.

**SANDY ULTIC SOILS**

**UY** Other Ultic Soils.

**YELLOW ULTIC SOILS**

### KEY TO SUBGROUPS OF ULTIC SOILS

**UD** DENSIPAN ULTIC SOILS

Densipan Ultic Soils have a high density but uncemented pan at shallow depth which severely limits root penetration and water movement. Surface soil horizons are seasonally wet and the soil is very susceptible to livestock treading damage.

**UDP** Soils that have a reductimorphic horizon below the densipan.

**Perch-gleyed Densipan Ultic Soils**

**UDM** Other soils that have a redox-mottled horizon immediately underlying the densipan.

**Mottled Densipan Ultic Soils**

**UE** ALBIC ULTIC SOILS

Albic Ultic Soils have an E horizon immediately beneath the topsoil. The surface soil horizons are seasonally wet and the soil is very susceptible to damage from livestock treading.

**UEP** Soils that have a reductimorphic horizon below the E horizon.

**Perch-gleyed Albic Ultic Soils**

**UEM** Other soils that have a redox-mottled horizon below the E horizon.

**Mottled Albic Ultic Soils**

**UEY** Other soils.

**Yellow Albic Ultic Soils**

**UP** PERCH-GLEY ULTIC SOILS

Perch-gley Ultic Soils have seasonal wetness close to the soil surface, indicated by grey colours in horizons immediately beneath the topsoil. The wetness is caused by perching on a clayey, slowly permeable layer, although a groundwater table may also occur. The topsoil is clayey.

**UPS** Soils that have more than 60% sand in the B horizon.

**Sandy Perch-gley Ultic Soils**

**UPT** Other soils that have a reductimorphic horizon with an upper boundary within either 15 cm of the base of the A horizon, or 30 cm of the mineral soil surface.

**Typic Perch-gley Ultic Soils**

**US** SANDY ULTIC SOILS

Sandy Ultic Soils occur in weathered aeolian sands. They have lower CEC and available water than is typical of Ultic Soils.

**USE** Soils that have an Ea or Er horizon.

**Albic Sandy Ultic Soils**

**USM** Other soils that have a mottled profile form.

**Mottled Sandy Ultic Soils**

**UST** Other soils.

**Typic Sandy Ultic Soils**

**UY** YELLOW ULTIC SOILS

Yellow Ultic Soils are clayey and lack densipans or thick E horizons. They are moderately well or imperfectly drained. Few are well drained.

**UYG** Soils that have *either*

1. 5% (by volume) or more coarse rock fragments that consists mainly of ultramafic rocks, *or*
2. have an exchangeable calcium/magnesium molar ratio of 0.2 or less and exchangeable magnesium of 1.5 cmolc/kg or more in some part of the B horizon to 60 cm from the mineral soil surface.

**Magnesic Yellow Ultic Soils**

**UYMZ** Other soils that have *both*

1. pH of 4.8 or less in the E horizon (if present) or uppermost B subhorizon , and 10% or more humus coatings or coatings of colour value 4 or less on peds in some part of the B horizon, *and*
2. a mottled profile form.

**Mottled-podzolic Yellow Ultic Soils**

**UYM** Other soils that have a mottled profile form.

**Mottled Yellow Ultic Soils**

**UYZ** Other soils that have pH of 4.8 or less in the E horizon (if present) or upper subhorizon of the B, and 10% or more humus coatings or coatings of colour value 4 or less on peds in some part of the B horizon.

**Podzolic Yellow Ultic Soils**

**UYBG** Other soils that:

1. have silt loam or silty clay texture dominant from the soil surface to a depth of 60 cm, *and*
2. exhibit a soil texture contrast to clay-textured horizons that have colour values of 4 or less

**Buried-granular Yellow Ultic Soils**

**UYT** Other soils.

**Typic Yellow Ultic Soil**

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# APPENDIX

The system for designating the soils consists of letters only. This method has been adopted to make for easier insertion of new subgroups, and to make the codes easier to remember.

The following table demonstrates how each code letter has been used in the soil classification, the level at which it has been used, and the meanings.

|  |  |  |  |
| --- | --- | --- | --- |
| **Code** | **Order** | **Group** | **Subgroup** |
| A | Anthropic | Acid, Aged-argillic | Acidic, Aged, Artifact, Active |
| B | Brown |  | Brown, Buried |
| C |  |  | Calcareous, Concre-  tionary, Cemented,  Compacted |
| D |  | Densipan | Pedal |
| E | Melanic | Melanic, Albic | Melanic, Earthy, Albic |
| F |  | Firm, Fibric, Fill, Fluvial | Fluid, Firm |
| G | Gley | Gley, Groundwater-gley | Gley, Gleyed, Magnesic, Granular |
| H |  | Humic, Hydrothermal | Thick, Humose |
| I |  | Immature, Impeded | Immature, Inactive, Ironstone |
| J |  | Argillic | Argillic |
| K |  |  | Alkaline, Tephric |

|  |  |  |  |
| --- | --- | --- | --- |
| L | Allophanic | Allophanic, Laminar, Litter | Allophanic, Laminar |
| M | Pumice | Mesic, Mafic, Mixed | Mottled, Mellow, Mafic |
| N | Granular | Nodular | Nodular, Sodic, Granular |
| O | Organic | Orthic | Peaty, Orthic |
| P | Pallic | Perch-gley | Pallic, Placic, Pumice,  Perch-gleyed |
| Q |  |  | Saline, Ortstein |
| R | Recent | Recent, Refuse, Rendzic |  |
| S | Semiarid | Sandy | Sphagnic, Sandy |
| T |  | Truncated, Tephric | Typic, Tailings |
| U | Ultic | Sulphuric, Duric | Sulphidic, Humus-pan,  Duric |
| V |  | Vertic | Vitric, Vertic |
| W | Raw |  | Weathered, Welded, Wet |
| X | Oxidic | Oxidic, Pan, Rocky, Fragic | Pan, Fragic, Rocky, Oxidic |
| Y |  | Yellow | Yellow, Ultic |
| Z | Podzol | Solonetzic | Podzol, Podzolic, Silt-mantled |

1. [↑](#footnote-ref-3)