Soils of Wellington

H. S. Gibbs[1]

INTRODUCTION

The soils of Wellington are the soils of Wellington. This reiteration is intended to emphasise the idea that soils are special bodies of materials with a particular relationship to the place where they occur. They "belong" to Wellington because the local climate, the plant and animal life, the drainage, the shaping of the land surface and other natural conditions all take part in making the soils out of the mineral and organic materials. Soils are not just accumulations of debris, they are products of the environment and as the environmental conditions around Wellington differ from those around Auckland, Christchurch or other places, so also do the soils. Likewise, within the Wellington area the soils of Miramar Peninsula differ from those of the cooler, wetter hills of Belmont or of the Akatarawa valley. By the same principle, however, similar conditions produce similar soils and one soil can occur in many areas.

IDENTIFICATION OF SOILS

The kind of soil of any place is rarely found by an inspection of the surface because that shows only the outer skin of the soil. The real identity is underground and is revealed in a vertical slice down from the surface to the limits of plant roots. This rooting depth may extend to 100 cm or more below the surface and some of the features to be seen at that depth are illustrated in Fig. 2–7. The slice through the soil is technically termed a profile, and for purposes of description it is divided into upper and lower parts. The upper part, commonly referred to as topsoil, consists of mineral and organic substances blended together by the activities of living plants and animals. The decomposing organic matter and the newly formed humic compounds give it a dark grey or brown colour and tend to make it friable and porous. Below 10, 15, 20 or more cm, depending on the soil-forming conditions, the colour changes to yellow, orange, red or pale grey and the soil material becomes more firm. This lower part is the subsoil and it consists mainly of new minerals formed from the rock materials and joined together into aggregates of various sizes and shapes with crevices through which roots, air and water circulate. Topsoil and subsoil are complementary parts of a soil and together they express the effects of local environment on the surface of the land. Hence, differences between soils are found by examining a series of soil profiles across the landscape and comparing the properties of the whole profile under differing site conditions. This is the basic method used in the identification of soils for mapping and for classifying them for various purposes.

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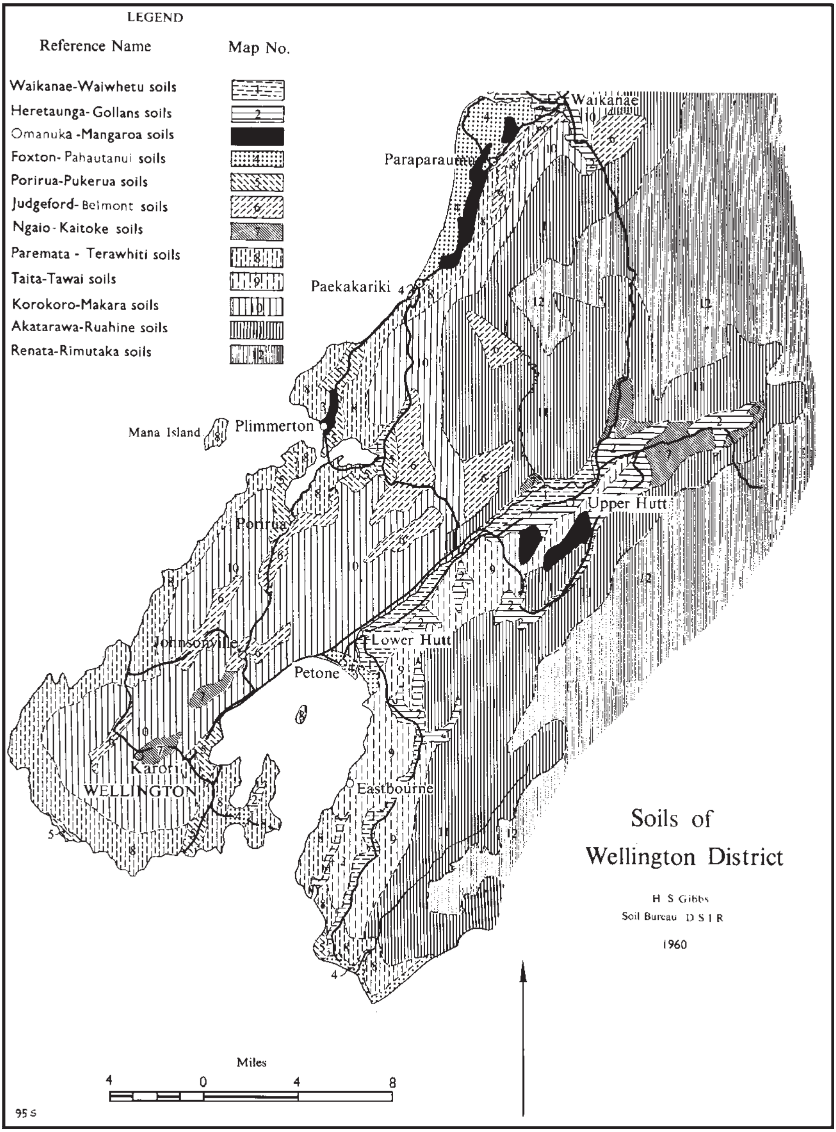

Fig. 1. Distribution of soils of Wellington.

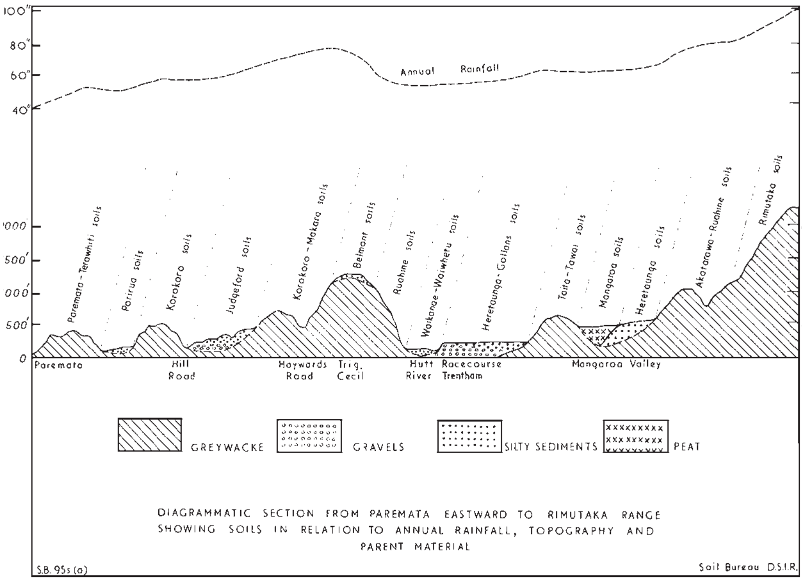

Fig. 2. Diagrammatic section from Paremata eastward to Rimutaka Range showing soils in relation to annual rainfall, topography and parent material.

GENERAL DESCRIPTIONS AND DISTRIBUTION OF SOILS

A long report and large map are needed to record all the detailed information on the soils of Wellington[2] but a classification based on distinctive differences separates the soils of Wellington into 24 kinds. Moreover, the broad distribution of these soils can be illustrated on a small map (such as Fig. 1), by grouping pairs or associations of soils formed from similar materials and differing in some important local condition such as drainage or slope. For reference, each soil is given a geographic name from one of the localities where it occurs. Individual soils and areas too small to show on the map may be recognised from the descriptive notes. As a lead to a more rapid identification of the soil of a site, the pairs of soils are separated into divisions of the landscape called lowlands and uplands. Lowlands comprise valley bottoms and beach lands, whereas the uplands are rolling, moderately steep and steep hills of the district.

SOILS OF THE WELLINGTON LOWLANDS

The soils of the lowlands are formed from recent accumulation of alluvium, windblown sands, or peats on valley bottoms or beach lands. On these sites the time for soil formation is limited by the age of the deposits so that little decomposition of mineral grains, removal of soluble constituents or development of

[2] For example, a detailed survey of 89 ha of land at Taita by Dr I. A. E. Atkinson separated 12 kinds of soil.

structure have taken place. The principal effect is the breakdown of organic matter and the incorporation of humic products into the upper part of the soil by the living organisms. These breakdown processes are rapid under moist mild conditions, and they blend organic and mineral parts together and increase the porosity of the soils. Four associations of lowland soils are separated.

The Waikanae-Waiwhetu soils are the loamy soils of the river flats in the Hutt and Wainuiomata valleys and in narrow valley strips elsewhere. The Waikanae soils are greyish brown sandy loams or silt loams over gravels generally at c. 1 m depth (Fig. 3). They are friable and free-draining to a depth of 60 cm or more. They generally occur near stream channels and grade into Waiwhetu soils on adjacent slower draining land towards the hills. As the rate of drainage decreases subsoils become paler in colour and less friable. Both soils are moderately well supplied in plant nutrients.

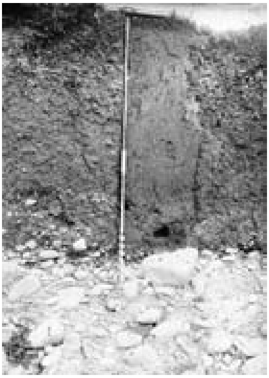

Fig. 3. Waikanae soils are the best soils for horticulture in the Wellington region. As they occur on the floodplains of the Hutt Valley, they are mainly in peoples gardens now where they could be used to great benefit.

The Heretaunga-Gollans soils occur in the Hutt, Wainuiomata and Waikanae valleys on alluvial terraces now raised above the level of river flooding. Heretaunga soils are free-draining brown to yellowish brown silt loams over stony gravels, whereas the Gollans soils are slow-draining grey to pale grey silt loams (Fig. 4). These soils are older and slightly poorer in plant nutrients than the Waikanae-Waiwhetu soils.

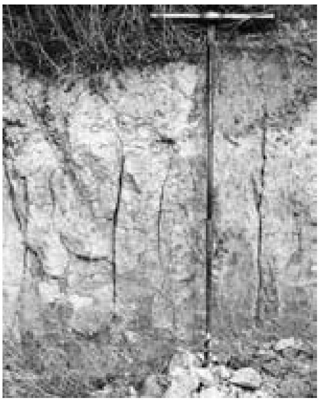

Fig. 4. On low-lying parts of higher terraces of the Hutt and Wainui rivers, Gollans soils which have poorly drained, grey, heavy and massive subsoils, are hard to work in gardens. They generally have rusty mottles between the dark topsoil and grey subsoil.

The Omanuka-Mangaroa soils are formed from peats which have accumulated in swamps where the high water table has prevented rapid decomposition of organic matter. Omanuka soils occur near Plimmerton and between Paekakariki and Waikanae. During peat accumulation, these swamps received additions of minerals from the erosion of adjacent hills or sand dunes, and with artificial drainage they become moderately fertile soils. On the other hand, most of the Mangaroa swamp did not receive mineral additions and the soils consist of only strongly acid fibrous peat.

The Foxton-Pauatahanui soils comprise sand soils of coastal lowlands. Foxton soils are derived from windblown sands and drain very rapidly. They have a high mineral content and organic matter decomposes quickly. Pauatahanui soils include raw sands on tidal marshes. Areas around Porirua and Wellington harbours have been reclaimed for building sites but most of the remainder should be kept for recreation and scenic reserves.

The soils of the lowlands are generally in small areas and the total extent of the lowland soils (12 000 ha) is less than one-tenth of the area of the district.

SOILS OF THE WELLINGTON UPLANDS

Eight soil associations are mapped on the 120 000 ha of rolling, hilly and steep lands in Wellington district. On these uplands the surface is closely dissected by streams and the soils are continually losing materials either by erosion of the surface or by solution in waters draining through the profile. These losses have been partially counterbalanced by weathering of minerals and the circulation of substances by plants and soil organisms. In contrast to the lowland soils, the processes have operated for a considerable time and have developed distinct differences in properties between topsoil and subsoil (Fig. 5–8).

The rock materials for soil formation on the uplands are either hard greywacke sandstone or weakly consolidated alluvial, volcanic or windblown materials deposited over the surface hundreds, thousands, or more years ago. Old soils buried by these deposits are revealed in roadcuttings and pits as brown, red or pale grey banding below the covering beds or the modern soil (Fig. 5). These features are important in showing events and environments of the past. Also the junction between the covering beds and the underlying soil or rock is liable to become a zone for accumulation of percolating water and a surface for slip erosion during wet periods.

The weakly consolidated cover deposits occupy most of the rolling and easy hill uplands of the district and are the parent materials of the following three associations of soils.

The Porirua-Pukerua soils are grey powdery silt or sandy loams over yellow compact clay loams. They have weakly developed aggregates increasing in size from small crumbs in the topsoil to large blocks in the subsoil. These soils are low in phosphorus but otherwise are moderately well supplied with plant nutrients.

The Judgeford-Belmont soils are brown friable silt or sandy loams over brownish yellow firm silt loams. They are free-draining with well developed fine nut aggregates. These soils are low in phosphorus, calcium and molybdenum.

The Ngaio-Kaitoke soils are greyish brown fine silt loams over yellowish brown compact clay loams. They are low in phosphorus, calcium and molybdenum, are slow draining and have poorly developed aggregation of the soil particles.

These three associations of soils are distributed in small areas of rolling land

Fig. 5. In road cuttings through rolling hill land, of Judgeford and Pauatahanui basin especially, layers of buried soils are obvious. These relics of previous cycles of erosion and weathering have been buried by successive additions of windblown materials (loess), blown from land exposed to the west during times of low sea level and trapped in depressions on earlier land surfaces, mainly since the last ice age.

throughout the district (see Fig. 1). Porirua-Pukerua soils occupy sites near the coast where they receive considerable quantities of sea spray, for example, near Island Bay, Titahi Bay and Pukerua Bay. Judgeford-Belmont soils occupy many inland sites on the western half of Wellington district from Makara to Waikanae. Good profiles are exposed in road cuttings in Ohariu and Judgeford valleys and on Belmont hills. Ngaio-Kaitoke soils occupy dissected plateaux at Karori, Ngaio, and north of Upper Hutt where the covering beds are older than those in other inland basins.

Five associations of soils are derived from greywacke and they occupy most of the hilly and steep land of the district. The first-named soil of the association represents the hilly component, and the second-named its steep counterpart.

Paremata-Terawhiti soils are grey powdery silt loams over yellow compact clay loams and clays. They are not as deep as the associated Porirua soils and contain weathering fragments of greywacke. Wind and sheet erosion have removed or truncated topsoils on many ridges. Moisture retention is low, soil structure is poor, and the subsoil is compacted. These soils occur in a zone

1.5–3 km wide around the Wellington coastline.

Behind the coastal strip from Waikanae to Island Bay the upland soils become more brown, more friable and have smaller, distinctly developed aggregates (Fig. 6). These are the *Korokoro-Makara soils* which extend from Brooklyn through Newlands and along the Western Hutt hills to Moonshine Valley. Moisture conditions are much more consistent than in the coastal uplands. Soil erosion is limited to rare shallow slips unless pastures are over-grazed.

East of Wellington Harbour and of the Hutt Valley up to Te Marua, the soils inland of the coastal strip are classed as *Taita-Tawai soils*. They are heavy soils

Fig. 6. Korokoro soils are shallow with thin topsoils and rich brown subsoils, that occur on rolling to moderately steep hill land of Karori, Tawa and inland Porirua, and west of Wellington Fault. Loess has not collected on, or it has been eroded from, these land surfaces and strongly fractured greywacke lies not far below the surface. These soils have limitations for gardening but are great for trees.

consisting of 7–10 cm of greyish brown firm clay loam over yellowish brown compact clay. Aggregates are poorly developed nuts and blocks of moderate to large size (Fig. 7). These soils are low in phosphorus, calcium and molybdenum.

North and east from the Korokoro-Makara and Taita-Tawai associations the upland soils become more brown and contain less clay. They are called *Akatarawa-Ruahine soils*. Under the native rimu, beech or kamahi forest the surface consisted of 4–7 cm of reddish brown raw humus. This organic store of fertility is safe under forest but is rapidly destroyed if the land is cleared for pastoral farming. Erosion exposes a topsoil that is low to very low in many

Fig. 7. East of the Wellington Fault, on the eastern Hutt Hills and around Wainuiomata and Upper Hutt, much of the greywacke has been deeply and strongly weathered in earlier warmer periods (indicated by red weathered rock). Taita soils on these slopes have clay subsoils and low fertility, and to farm them requires much effort and fertiliser or they become colonised by gorse with its nitrogen-fixing ability. Their best use is for forests.

plant nutrients and frequent topdressing with phosphates and lime is required to maintain pastures. Otherwise fern and shrubs rapidly invade pastures as has happened in many parts of the Akatarawa and Wainuiomata valleys.

Above 450 m the soils are strongly acid shallow loams with thick raw humus covering (Fig. 8) and are mapped as the *Renata-Rimutaka soils*. Mineral nutrients are low to very low and after erosion the formation of new soil is very slow. These soils are in native forest and removal of timber or intensive grazing by deer, goats and possums is liable to destroy the surface litter and result in increased run-off, less water storage, and extensive flooding on the lowlands. These hazards from plant depletion increase with altitude and are particularly serious above 1000 m in the Tararua Range.

The five upland soils derived from greywacke are observed across the district in successive belts with a pattern of distribution similar to the zones of climatic differences. Around the coast, where the climate is mild and subhumid, are the Paremata soils which have high clay content and moderate levels of nutrients. As the climate becomes cooler and wetter inland, the Paremata soils grade into Korokoro soils (Fig. 1, soil no. 10), which inland pass into Akatarawa (soil

Fig. 8. At higher altitudes (above 450 m) on the Tararua and Rimutaka Ranges, where leaf litter and humus accumulates because of higher rainfall and low evaporation, Renata soils on slopes <30° have thick humus layers over pale ashy layers, with weakly weathered and strongly jointed greywacke close to the surface. Iron staining along rock faces may be present. They need the protection of their forest cover or they will erode.

no. 11) and then into Renata soils (soil no. 12). This sequence of soils shows a progressive decrease in content of clay and of nutrients caused by a slower rate of weathering and a greater rate of leaching from Paremata to Renata soils. Weathering and leaching are processes that are strongly influenced by temperature and rainfall and the above sequence of soils from one rock material is an excellent illustration of the influence of climate on soil formation.

The Taita soils (Fig. 1, soil no. 9) are out of climatic order in the distribution pattern in that they contain more clay and are more leached of nutrients than the Korokoro soils. This anomaly is explained by the greater age of the Taita soils as a consequence of their occurrence east of the Wellington Fault where land has been uplifted and eroded to a much lesser extent than land of the Korokoro soils. Under these conditions there has been more time for decomposition of minerals and for the accumulation of the less soluble products of soil formation on the Taita soils. In support of this geologic explanation, road and railway cuttings through the Taita soils reveal exceptional thickness of weathered greywacke including remnants of reddish products of ancient weathering in many places.

Dark red loamy soils over purplish red rocks occur in some narrow strips of hill country east of the Hutt Valley and may be seen in cuttings on the Rimutaka Hill road. These soils are derived from lenses of volcanic lava injected into the greywacke bedrock and are rich in plant nutrients.

The correlation of soil pattern with climate described above is also expressed in a similar manner between the native vegetation and the soils: coastal broadleaved forest on the Paremata-Terawhiti soils, broadleaved and podocarp forest on the Korokoro-Makara soils, podocarp and beech forest on the Akatarawa-Ruahine soils, beech and podocarp forest on the Taita-Tawai soils, beech and kamahi forest on the Renata-Rimutaka soils. Under broadleaved trees such as kohekohe and tawa, the rapid decomposition of litter assisted the maintenance of nutrients and promoted aggregation in the soils; whereas under the podocarps, rimu and miro, or the hard beech, silver beech or kamahi, the slow decomposition of litter led to rapid depletion of nutrients and to weak development of structure in the topsoil.

Curious Growth of Tawa

Frances Duguid[1]

A tawa tree in the Papaitonga bush on a low sandstone bank was seen to have fallen over to an angle of about 30° below horizontal, with the roots still clinging to the bank, at a point c. 1.5 m above the level of the swamp in the gully beside it. Since it had been thrown, the tree had grown six new vertical trunks, having the following circumferences, commencing with the new trunk nearest the roots: 95 cm, 73 cm, 66 cm, 62 cm, 21 cm, and 27 cm. It will be seen by the foregoing that instead of progressively decreasing in size, the last trunk was larger than the preceding one. It was noted that the original trunk had fallen into a shallow drain at the edge of the swamp, and the increased size of the new upright trunk beyond this suggests that roots had grown from the underside of the prone trunk, giving the new trunk the benefit of additional moisture and nutriment. The tip of the old trunk extended further, and was not traceable through the thick undergrowth, but there did not seem to be any further vertical growth. (Seen 14 July 1973.)

Tawa beside Lake Kopureherehe (seen July 1972) looked as if two trees had become grafted together by their roots above ground. Autografts of tawa branches are by no means uncommon in the Arapaepae hills (seen c. 1970).

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