SOILS OF NELSON DISTRICT

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For the purpose of this paper the description of soils in the Nelson district has been restricted to those in the Waimea County, particular attention being given in the paper to those soils which are used for agriculture.

TOPOGRAPHY OF WAIMEA COUNTY

The Waimea County, situated at the head of Tasman Bay, comprises approximately 1500 square miles. Nearly 60 per cent. of the land -consists of' steep hills and mountains which rise both in the east and west to over 5000 feet. The farm land located in the middle area of the county is sheltered) from severe gales by the mountains lying to the east, south, and west. The land lies open to the sun and is well watered by the Maitai, Wairoa, Motueka and Riwaka River systems.

CLIMATE

The Nelson district is well known for its sunshine, which averages nearly 2500 hours per annum. The rainfall of the Waimea County varies from 36.4 to over 60in. per annum at different locations. The Appleby Research Orchard at the seaward end of the Moutere gravel formation has an average annual rainfall of 36.4in.; Nelson averages 38.2in.; Motueka 47.9in.; Wakefield 47.4in.; and Golden Downs on the Upper Motueka River 48:Oin. The rainfall in the eastern mountains and in- the southern and south-west sectors of the country is much higher, attaining 60 to 70in. per annum.

The climate is more temperate, than in many parts of the South Island. The mean maximum temperature for Nelson is 63.4 degrees F. and the mean minimum 45.2 degrees F. While frosts of 10 degrees to 13 degrees are common on the Waimea Plains and inland valleys during the winter, Nelson and other locations bordering Tasman Bay seldom exceed 6 degrees to 7 degrees of frost.

The sheltered position of Waimea County together

with its high sunshine and good distribution of rain provide favourable conditions for the culture of fruit, tobacco, hops and market-garden crops.

GEOLOGY

The soils of the county are influenced greatly by the different geological formations from which many soils acquire distinctive characteristics.

In few districts of comparable size in New Zealand is the geology so varied in character. On the eastern side of the county the hills and mountains consist mainly of greywacke and argillites belonging to the Maitai series. On the western side of this formation there is a narrow outcrop of triassic shales and sandstones which border the Waimea Plains. In the Nelson-Wakapuaka sector of the county the greywackes and argillites of the Maitai series are flanked by basic igneous rocks of augite-porphyry and syenite. An important feature of the eastern mountains is the occurrence on what is known as the Mineral Belt of ultra-basic rocks of serpentine and dunite. These rocks extend from the head of the Maitai River in a narrow belt to Lake Roto-iti.

Occupying a very large area in the central part of the county is a vast deposit of gravel, silt, and sand known as the Moutere gravels. This deposit is considered by geologists to have been laid down by some ancient river system flowing into Tasman Bay in Pleistocene times. The gravels cover some 300,000 acres of country and extend from Tasman Bay to Glenhope.

On the western side of the Moutere gravel formation an outcrop of granite occurs. The granite extends from Kaiteriteri Peninsula through the Motueka Valley to the Dart and Sherry Rivers.

The granites, are flanked in turn by basic igneous rocks (gabbros. and dolerite) which attain their maximum development in the vicinity of Umakuri and Riwaka. On the extreme western boundary of the county are the marbles and schists, of the Mt. Arthur Range and the slates and greywackes of the Baton and Wangapeka watersheds. In addition to the above-mentioned major geological formations of the county, clays and sandstones of Miocene age outcrop at Bishopdale, Stoke and in the Sherry and Tadmor Valleys.

PRIMEVAL VEGETATION

With the exception of a coastal fringe comprising

the Port Hills, the Waimea Plains, and the seaward end of the Moutere gravel formation, the land was clothed in forest: mixed beech and podocarp in the valleys and *Nothofagus* species on the greater part of the hill and mountainous country. Elevated plateau country above the forest line was clothed with native grasses. The coastal fringe in the vicinity of Nelson, the Waimea Plains, and the Moutere gravels at Tasman is reported to have had a covering of scrub and native grasses at the time of European occupation.

SOILS OF WAIMEA COUNTY

The Soil Bureau, Department of Scientific and Industrial Research, has classified the soils of the county as belonging mainly to the yellow-brown earths. They have been developed under a forest cover with a rainfall exceeding 40ins. per annum. Their properties are influenced not only by leaching effects of the higher rainfall country but by the nature of the parent material from which the soils are derived. The soils of the coastal fringe formerly clothed with scrub and grass have been classified as yellow-grey earths.' Here again the nature of the parent material exerts a profound influence on the properties of the soils.

In no part of New Zealand do the soils show greater variation in properties than those of the Waimea County. This is due to the great differences in the parent material from which the soils are derived. This variation is very marked in the skeletal soils of the mountains, but it is also seen in the alluvial soils of different river systems in the county.

The reconnaissance survey of the county made by the Cawthron Institute many years ago resulted in the identification of some 24 main soil types. For purposes of description the soils may be grouped under the following headings :

(a) Soils of the mountains and foothills covering some 594,000 acres of mountainous and hilly country on the eastern, south-western, and western sides of the county.

(b) Soils of rolling country of more gentle topography covering about 300,000 acres in the central part of the county.

(c) Young and recent soils associated with the rivers and streams in the county. These soils cover some 75,000 acres of land. Included within this group

are the sand-dune soils and one type named Maori which was made or treated by the ancient Maoris who cultivated lands in Waimea West, and at Motueka.

SOILS OF' MOUNTAINS AND FOOTHILLS

In the soil surveys of the Cawthron Institute seven main groups or associations of soils have been delineated. They have been named Wairoa, Kaiteriteri, Pikikiruna, Brooklyn, Atawhai, Dun and Heslington. In each case the name indicates a locality or topographical feature where a typical area of the soil occurs.

They are associated with the following geological formations which influence greatly the properties of the soils: Wairoa with the Permo-Carboniferous argillites and greywackes of the Maitai beds and with the closely related slates and greywackes of Silurian and Ordovician age in the Baton and Wangapeka watersheds ; Kaiteriteri with the granite rocks of Kaiteriteri Peninsula, Motueka, Dart, and Sherry Valleys; Pikikiruna with the marble outcrops of the Takaka Hills; Brooklyn with the basic rocks of the western mountains; Atawhai with the augite-porphyries and syenites of the Nelson-Wakapuaka Hills ; Dun with the serpentine outcrops of the Mineral Belt country of the eastern mountains ; Heslington with Triassic shales and sandstones which fringe the eastern slopes of the Waimea Plains from Richmond to Lake Roto-iti.

It must be emphasised that within each group or association enumerated several soil types or sub-types may occur, depending on differences in topography, vegetative cover, or parent rock. A more detailed survey of these groups of soil will entail their subdivision into more conventional soil units based on profile characteristics.

Officers of the Soil Bureau and the Cawthron Institute are co-operating with a view to the delineation of such units.

The Wairoa soil group comprises some 250,000 acres of the eastern mountains and 50,000 acres in the watersheds of the Baton and Wangapeka Rivers. With the exception of the western fringe of the main area in the eastern mountain district, the topography is steep with narrow valleys. Most of the country is in native bush which is required to regulate river flow and to prevent soil erosion. The soils are frequently very shallow and skeletal in character. They have a low value for farm purposes.

The Kaiteriteri group of soils covers some 137,000

acres of granite country, much of which is steep and unsuitable for farm use. Large areas of the Kaiteriteri soils in the upper Dart and Wangapeka Valleys are still in forest, but much of the granite country bordering the Motueka River has been cleared and sown to grasses. Poor results have been obtained on much of the country, reversion to bracken and scrub being very common. On the easier country on the eastern side of the Motueka River between Ngatimoti and Stanley Brook the results have been better.

Another soil of great, interest but of very low agricultural value is that named Dun. This soil is derived from the serpentine outcrops of the eastern mountains. It covers some 32,000 acres of steep hill country and carries a sparse vegetation of native grasses and manuka. The soil is shallow and strongly influenced by the underlying serpentine rocks. It is high in magnesia and low in lime and other plant foods.

The Atawhai and Brooklyn soil groups on the other hand are valuable for pastoral purposes. They are derived from basic rocks which contain lime and other bases in satisfactory amount. Where topdressed with superphosphate good pastures can be obtained. The area of Atawhai is estimated at 15,600 acres and that of Brooklyn at 21,800 acres.

Another soil group esteemed for pastoral purposes is Pikikiruna covering some 73,700 acres of limestone country in the western mouritains. The altitude of much of the Pikikiruna type restricts grazing to the summer.

The Heslington soil group covers 13,000 acres of foothill country flanking the Waimea Plains. The soils have a good lime status and are well supplied with plant food. They have proved valuable for farming., On the steep slopes facing the Waimea Plains the soils are frequently used for early pea and potato culture.

The total area of soils included within the mountain and foothill division comprises about 594,000 acres. It is doubtful whether more than 100,000 acres can be used successfully for agriculture.

SOILS OF ROLLING COUNTRY

In the' reconnaissance survey of the Cawthron Institute five distinct types of soil were recognised on the rolling country in the central area of the Waimea County. They were named Moutere, Bishopdale, Tadmor, Matariki and Wakatu.

The Moutere soils have been derived from a vast deposit of Pleistocene gravels, silt and sand. They extend from Tasman on the coast to Glenhope and have an average width of 12 miles with a maximum development near Wakefield of 16 miles. They cover some 285,000 acres of rolling and hilly country. With the exception of the coastal area, which was clothed with native grasses, bracken, and manuka, the whole of the Moutere formation was in beech forest when the Nelson settlement was established. Much of the land has been cleared and occupied for agriculture. Good results were obtained in the early years, after the felling and burning of the bush, but pastures quickly deteriorated and large areas have reverted to bracken and manuka.

Two interesting developments have taken place during the last 40 years. Apple orchards have been established on the seaward end of the formation. Although a comparatively large area of orchards for different reasons proved uneconomic, some 2600 acres remain and are giving excellent results.

The other development has been the establishment of pine plantations. The New Zealand Forest Service has extensive plantations of *Pinus radiata* and *Pinus ponderosa* in the Kohatu-Belgrove locality and private interests have been responsible for smaller plantations at Belgrove, Wakefield, Braeburn, and Tasman. The pine plantations have made excellent growth and are now supplying a large quantity of millable timber.

In recent years great interest has been taken by farmers in the development of ploughable country for grazing purposes. With the use of heavy machinery and the latest information. concerning the establishment of grasses and clovers, considerable areas of the easy country have been brought into production. Moutere soils are deficient in lime and phosphate and are low in potash, magnesia, and certain trace elements. More detailed surveys conducted by the Soil Bureau and, officers of the Institute have. shown the desirability of subdividing Moutere soils into six soil types based on profile characteristics. They are as follows: Mapua clay loam located on the coastal section of the Moutere formation; Rosedale silt loam; Stanley silt loam ; Spooner stony silt loam ; Korere silt loam, and Hope silt loam. Of these soils Mapua clay loam is regarded as a yellow-grey earth and the other soils are classed as yellow-brown earths. The Stanley silt loam, which shows less reversion of pasture to bracken and

manuka has a better base status than other soils of the Moutere group.

The Tadmor, Bishopdale, Wakatu, and Matariki types have a restricted distribution. They are used for pastoral purposes and respond to both lime and phosphate treatment. Of the four soils Wakatu is the most extensive in area and the most valuable for pasture establishment.

RECENT AND YOUNG SOILS

The soils of this group comprise recent alluvial soils, terrace soils, dune sands, and the soil made by the ancient Maoris. They cover an area of some 75,000 acres scattered up and down the Waimea County. The two most important areas of alluvial soils are the Waimea and Motueka Plains. Some 1'2 types have been identified in the soil surveys of the Cawthron Institute. They frequently show marked differences in properties dependent on the proportion of different types of rock fragments from which the soils are derived.

In order of agricultural importance, the soils may 'be listed as follows : Riwaka, Waimea, Motupiko, Maori, Stoke, Umukuri, Tapawera, Nelson, Sherry, Wangapeka, Gordon and Quail.

With the exception of Maori, which is dark because of charcoal particles, the soils are brown or grey-brown. Several of the soils listed above contain more than one textural type, for example, sand, sandy loam, silt loam, etc.

The Riwaka soils which cover much of the flood plain of the Motueka and Riwaka Rivers are well known for their fertility and good textural qualities. They are widely used for tobacco, hops and fruit culture. The derivation of the soils from a great variety of geological formations including both basic and acidic rocks ensures good textural qualities and a satisfactory mineral composition.

The Waimea group, particularly the more recent silts and sands of Brightwater and Waimea West, are likewise noted for good crop production. This results in no small measure from the mixture of rock fragments deposited by the Wairoa River and its tributaries which have access to argillites, serpentines, triassic shales, and Moutere gravels. Analyses of the recent silts and sands show a very good base status of the soils with comparatively high figures for magnesia. The Maori soils are associated with both Waimea and

Riwaka types and were made by the ancient Maoris by depositing sand and fine gravel over the loams which are the common textural types in the localities where Maori soils occur. Soil fertility was improved by the frequent burning of scrub and other vegetable matter on the surface of the land.

The Motupiko soil group has a wide distribution in the county. Important areas- of the soil occur in the Motupiko and Tadmor Valleys, and in the Moutere, Dovedale, Stanley Brook, and Wai-iti Valleys. The soils are derived in great part from the resortment of Moutere gravels and the erosion of the Moutere gravel formation. Although they have a better lime and phosphate status than Moutere soils, they require liberal treatment with both lime and phosphate for satisfactory pasture production. The soils are used for pasture, tobacco, hops and small fruits. For all intensive crops mixed fertilisers containing nitrogen, phosphate and potash are desirable. Deficiencies of trace elements are common on the soils.

The Umukuri, Sherry and Wangapeka soil. groups have a more restricted distribution. In each case granite rocks have provided a major proportion of the rock particles in the soils. They differ solely in the amount of other rock particles, for example, basic rocks, argillites, and clays, present in the soils. They are all acid soils, but care must be exercised in liming; too large amounts frequently result in boron deficiency symptoms in crops. The Sherry and Wangapeka soils are low in both phosphate and potash.

The Nelson, Tapawera, Gordon, and Waimea soils are derived in part from the serpentine rocks of the eastern mountains. The somewhat high content of magnesia in the recent silts and sands of the Waimea has been commented on already. In the case of the Gordon soils the proportion of serpentine rock component is so high as to render the soils of low agricultural value. These soils are neutral or slightly alkaline with low lime and high magnesia contents. Production of pasture is poor. The only farm crop-which does comparatively well on the soils, is ryecorn. The Tapawera soils are likewise influenced greatly by a high proportion of serpentine rock particles, but in this case debris brought down by the Motupiko River from the Moutere gravels effects an amelioration of soil characteristics with a lower content of replaceable magnesium. Good growth of lucerne, clover, and pasture is obtained on these soils if treated with superphosphate. Tobacco

likewise grows well, but the quality from the manufacturer's viewpoint is impaired by a high magnesium content, which promotes rapid combustibility of the manufactured leaf. Nelson soils by virtue of their derivation from a greater assortment of rocks, including argillites and augite-porphyry, have high lime and magnesia contents. The soils have proved valuable for tomatoes and market-garden crops, but special attention must be paid to the use of relatively large amounts of potash in the manurial treatment of tomatoes in order to counterbalance the effect of the high magnesium content of the soils.

SOIL DEFICIENCIES' IN WAIMEA

As might be expected from soils of the yellow-brown earths, acidity and a poor lime status are frequent. All soils of the Moutere gravel formation, Kaiteriteri soils derived from granite, Wairoa soils derived from argillites and sandstones, Motupiko soils derived from Moutere gravel resortment, and Sherry and Wangapeka soils derived mainly from granites are all acid soils which require lime treatment to obtain good results with pastures and many farm crops. Chief exceptions to the need for liming are soils derived from. Triassic shales (Heslington soils), basic igneous rocks (Atawhai and Brooklyn soils), and from limestone? (Pikikiruna soils). Certain alluvial soils likewise possess a good base status and lime treatment is required infrequently. Among these soils may be mentioned the recent sands and sandy loams of Riwaka and Waimea, the Tapawera, and Nelson soils.

With the exception of Riwaka sands, all soils in the Nelson district are low in phosphate and require liberal treatment with phosphatic manures to obtain optimum yield of farm crops. Deficiency of phosphate is particularly marked in all soils of the Moutere gravel formation, Kaiteriteri soils and Dun and Motupiko soils. Although potash is in somewhat better supply than phosphate in many soils, low figures frequently occur in soils of the Moutere gravel formation and in Motupiko soils. Tobacco, hops, apples, small fruits, and tomatoes all require potassic manures for optimum yield and quality on a wide range of soils.

Among' the more interesting deficiencies identified in the Nelson district are those of the minor elements -cobalt, boron, copper, molybdenum, and magnesium.

COBALT DEFICIENCY

This deficiency has been identified by officers of the Cawthron Institute at Glenhope and in the Sherry

Valley. The soils associated with this deficiency are Kaiteriteri and Sherry, both derived from granite. Figures as low as 1 p.p.m. cobalt in these soils are not uncommon. Soils of the Moutere gravel formation tend likewise to be low, but no proved case of cobalt deficiency in stock has been identified. The use of cobalt sulphate incorporated in superphosphate at 202. per acre has proved entirely satisfactory in overcoming cobalt deficiency in sheep both on Kaiteriteri and Sherry soils.

It is interesting to note that certain soils in the Nelson district are very high in cobalt. Among these may be mentioned Gordon, Tapawera, and Nelson soils, which may contain 40 to 60 p.p.m. cobalt, and Dun soils, which sometimes show cobalt figures exceeding 200 p.p.m.

BORON DEFICIENCY

This deficiency has been identified in several crops by officers of the Department of Scientific and Industrial Research and of the Cawthron Institute.

The soils which show marked deficiency of this element are those of the Moutere gravel formation, the Kaiteriteri soils, and Motupiko soils. Under particular conditions of lime treatment boron deficiency symptoms may occur on sandy soils of other types in many parts of the Nelson district. Perhaps the mostinteresting case of boron deficiency identified in the district is that of internal cork or corky pit in apples. This defect, shown by a pitting of the surface or by a browning in the tissue of apples, has been overcome by the use of ½lb. of borax per tree or by the use of borax as a spray on the trees in the spring at a strength of 0.1 per cent.

Other cases of boron deficiency identified in the district are dieback of raspberry canes and delayed growth of hops. In both cases the deficiency has been overcome by the use of ½oz. of borax per raspberry bush or hop hill. Brown heart of swedes and turnips has a much wider distribution on soils of the Nelson district, although it is most apparent on the Kaiteriteri and Moutere soils. The trouble is overcome by the use of 201b. borax per acre distributed and harrowed into the soil before the sowing of the crops.

COPPER DEFICIENCY

This deficiency has been identified in tobacco by officers of the Cawthron Institute and the Tobacco

Research Station near Motueka. It causes a break down of tobacco leaf. The affected leaf has a high protein and low sugar content. Great improvement in quality of leaf has been effected by the use of 561b. of copper sulphate per acre as a soil dressing. The trouble is associated with sandy soils, particularly those of the Kaiteriteri and Moutere groups.

Copper salts likewise appear to be beneficial for raspberries on certain sands at Motupiko belonging to the Motupiko group of soils.,

MOLYBDENUM DEFICIENCY

Analyses of typical samples of a wide range of soils in the Nelson district have shown that in certain cases very low contents of molybdenum occur. Similar methods of extraction to that employed by other workers have shown that the content of molybdenum frequently parallels those of Australian and other New Zealand soils where applications of molybdenum have given striking results on growth of clovers and other plants.

The three groups of soils in the Nelson district which are outstandingly low in molybdenum are those of the Moutere gravel formation, the Kaiteriteri soils derived from granite, and the Dun and Gordon soils derived from serpentines. For these three groups of soils figures as low as 0.03 p.p.m. of available molybdenum are common. Responses to the use of sodium molybdate have been obtained by the Department of Agriculture, the Cawthron Institute, and by several farmers in the case of pasture on the Moutere gravel and Motupiko soils.

The exact conditions under which responses to sodium molybdate may be obtained are not yet known, but work is proceeding by officers of the Institute to ascertain lime and molybdenum relationships and the need for molybdenum supplements in the case of apples, hops, tobacco, small fruits, and other crops.

MAGNESIUM DEFICIENCY

Although magnesium cannot be considered a trace element, as it is taken up by many crops in relatively large amounts, few cases of magnesium deficiency have occurred in other parts of New Zealand. Crops in the Nelson district, however, have provided several interesting cases of this deficiency. Officers of the Cawthron Institute have identified premature defoliation of apples as a magnesium deficiency ailment. This

trouble occurs to a minor or serious extent in many orchards located on Mapua and Rosedale loam. It also occurs in orchards in the Moutere Valley, where the soil belongs to the Motupiko group. In severe cases magnesium deficiency results in the dwarfing of trees, low crop yield, and poor quality of the fruit. The trouble may be overcome by the use of ground dolomite at 61b. per tree.

Tobacco likewise may be affected adversely by low magnesium content of the soil. This is accentuated if growers are-using large applications of potassic manures in the treatment of their crops. Deficiency of magnesium causes a mottling and in severe cases a blanching of the leaf. The quality of the leaf and yield are adversely affected. Magnesium deficiency is common on sands of the' Kaiteriteri, Riwaka and Moutere groups of soils. In the case of tobacco the use of 5cwt. per acre of ground dolomite is recommended for severe magnesium deficiency. As a precautionary measure ground dolomite or magnesite is now incorporated in many tobacco fertiliser mixtures in such proportion as to provide about 20lb. per acre of actual magnesia (MgO) in the usual dressing of fertiliser.

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